
THE
DAVID DUNLAP
OBSERVATORY

LETTERS NEWSPAPER CLIPPINGS PRINTED ARTICLES AND PHOTOGRAPHS *Relating to the* DAVID DUNLAP OBSERVATORY

Presented to

DAVID MOFFAT DUNLAP

by his

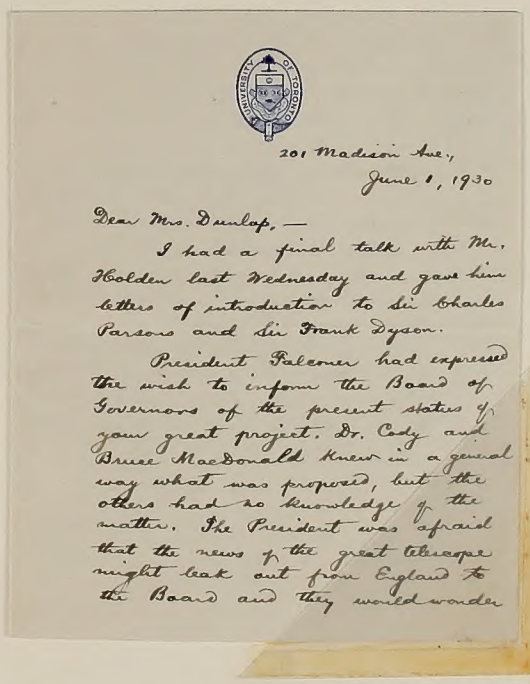
MOTHER

CHRISTMAS 1934

THE DAVID DUNLAP OBSERVATORY

In January 1927 Mrs. Dunlap informed Professor C.A. Chant that she was willing to provide an observatory for the University of Toronto, to be erected in the neighborhood of Toronto and to be a memorial to her husband, who died October 29, 1924. She stated however, that the actual work of construction would have to be delayed for three years. This time was spent in selecting a suitable site and in securing information about equipment. The order for the great telescope was given to the firm of Sir Howard Grubb, Parsons and Co., of Newcastle-on-Tyne, England, in May 1930, although the actual contract was not signed until the autumn of that year.

In the summer of 1931 there was some discussion regarding a public announcement of the project.

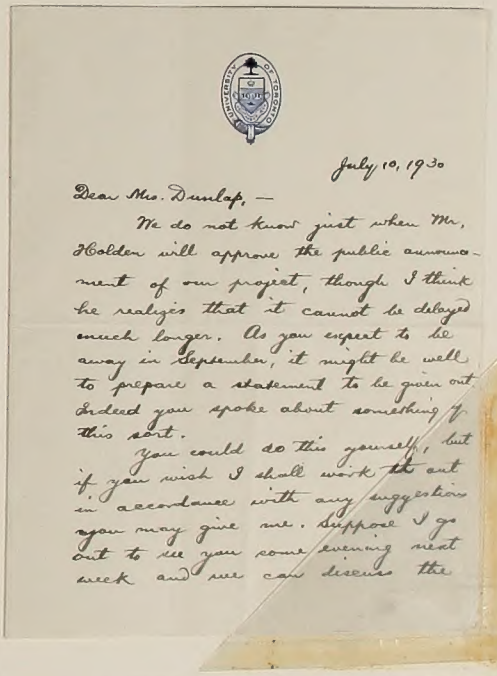


201 Madison Ave.,
June 1, 1930

Dear Mrs. Dunlap, —

I had a final talk with Mr. Holden last Wednesday and gave him letters of introduction to Sir Charles Parsons and Sir Frank Dyson.

President Falconer had expressed the wish to inform the Board of Governors of the present status of your great project. Dr. Cody and Bruce Macdonald knew in a general way what was proposed, but the others had no knowledge of the matter. The President was afraid that the news of the great telescope might leak out from England to the Board and they would wonder

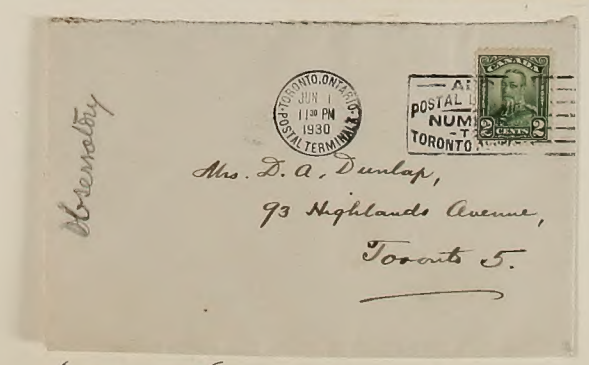


July 10, 1930

Dear Mrs. Dunlap, —

We do not know just when Mr. Holden will approve the public announcement of our project, though I think he realizes that it cannot be delayed much longer. As you expect to be away in September, it might be well to prepare a statement to be given out. Indeed you spoke about something of this sort.

You could do this yourself, but if you wish I shall work it out in accordance with any suggestions you may give me. Suppose I go out to see you some evening next week and we can discuss the



Observatory

Mrs. D. A. Dunlap,
93 Highlands Avenue,
Toronto 5.

Mrs. D. A. Dunlap,
Don Alda Farm,
Todmorden P.O.
Ont.

Letters Regarding Announcement of the Observatory Project

Mrs. Dunlap and Professor Chant
At Don-Alda Farm, June 1929

PROVISIONAL

A GREAT MEMORIAL

The important announcement has just been made that in the near future there will be established in the vicinity of Toronto an astronomical observatory which will rank with the world's greatest institutions of this sort. It will be erected by Mrs. D.A.Dunlap as a memorial to her husband David A. Dunlap, who died on October 29, 1924, and will be known as the David Dunlap Observatory.

Astronomy and geology were both favorite studies of Mr. Dunlap, but the former had a peculiar attraction for him. He was an intelligent student of the heavens and was always pleased to share his interest with others. This great project which has been under consideration for the last five years will now be brought to completion. In working out the plans Mrs. Dunlap has had the assistance of Professor C.A.Chant.

The outstanding feature of the observatory will be a great reflecting telescope 74 inches in diameter. There is only one larger than this in the world, namely that at Mount Wilson in California. The instrument was ordered some time ago from the firm of Sir Howard Grubb, Parsons and Co., Newcastle-on-Tyne, England. It will be housed in a circular metal building, such construction being best for this purpose. The observatory building will be a beautiful structure in the classic style. The site chosen is on a prominent elevation just east of Yonge St. and one mile south of Richmond Hill. It is in the middle of a -acre plot of land which will be made into a park to be known as the David Dunlap Park.

When the observatory is completed it will be operated by the Department of Astronomy of the University of Toronto, while the Park will be developed in a scientific way by the Faculty of Forestry.

It is believed that the new institution will bring distinction to the city, the province and indeed the whole dominion. It will be a noble memorial to a notable Canadian. lasting

First Draft of Announcement of Project

THE GLOBE, TORONTO, TUESDAY, DECEMBER 30, 1930.

New Observatory to Rival World's Best

Wonder Telescope Will Be Situated On Site Near City

DONATES FINE GIFT

MRS. DAVID A. DUNLAP
Who, with her son, D. Moffat Dunlap, will build an astronomical observatory near Toronto as a memorial to her husband, the late David A. Dunlap. The second largest reflecting telescope in the world will be installed.

Munificent Gift of Mrs. David A. Dunlap and Her Son Will Provide Toronto Area With Astronomical-Study Equipment Second Only to That of California

WILL BE BENEFIT TO UNIVERSITY

Department of Astronomy Will Have Facilities Available for Students, and Surrounding David Dunlap Park Is to Be Under Care of Faculty of Forestry

An astronomical observatory which, it is claimed, will rank with the finest in the world will be established in the near future in the vicinity of Toronto, according to announcement made yesterday by Professor Clarence A Chant, head of the Department of Astronomy of the University of Toronto. The observatory will be known as the David Dunlap Observatory, and will be erected by Mrs Dunlap and her son, D. Moffat Dunlap, as a memorial to the late Mr Dunlap, who died on Oct 29, 1924.

The outstanding feature of the observatory will be a large reflecting telescope seventy-four inches in diameter. It is stated that there is only one greater aperture in the world, namely, that on Mount Wilson, in California. The instrument is already under construction by the firm of Sir Howard Grubb, Parsons & Company, Newcastle-on-Tyne, England. It will be housed in a circular metal building, such construction being best for this purpose.

In Classic Style.

The observatory building will be a beautiful structure in the classic style. It will be erected on a suitable site near Toronto—probably near Thornhill—in the midst of a large acreage which will be converted into a park to be known as the David Dunlap Park. When the observatory is completed it will be under the Department of Astronomy of the University of Toronto, while the park will be developed in a scientific way by the Faculty of Forestry.

Astronomy and geology were both favorite studies with the late Mr Dunlap. He was a keen student of the heavens, and enjoyed sharing his knowledge with others.

This project has been under consideration for the past five years, and is now being brought to completion. In working out the plans Mrs Dunlap has been assisted by Professor Chant.

No further information was given out officially beyond what was contained in the statement. Professor Chant said the exact site of the building had not yet been determined, nor was the price known. Mrs. Dunlap courteously declined to add anything whatever to the official statement.

The Department of Forestry had not heard anything of the gift, and did not know it was to earn for the grounds. University officials who might have known something of the project were out of the city last night.

Though meteorological buildings come under the Department of Marine at Ottawa, apparently observatories do not, as Ottawa knew nothing of the Dunlap gift.

Handsome Gift.

The meaning of this exceedingly handsome gift by Mrs Dunlap and her son to the University of Toronto was explained to The Globe last night by A. R. Hassard, K.C., Vice-Chairman of the Royal Astronomical Society of Toronto, who has long been interested in the study of astronomy. "Anything that Mrs Dunlap will do can be depended upon to be the very best," said Mr. Hassard, in expressing his pleasure at the news.

"Both Mr and Mrs. Dunlap came to our meetings," explained the Vice-Chairman, who recalled that Mr. Dunlap was a lawyer and mining man. Since the death of her husband Mrs. Dunlap has been exceedingly interested.

Two years ago last fall, when leaders of the Royal Astronomical Society of England visited Toronto, Mrs. Dunlap entertained the delegates.

Vice-Chairman Hassard said such an observatory to be adequately located would be built on high ground, probably up Yonge Street about Thornhill. The site of the De La Salle Institute, at Aurora is the highest point in York County, but Mr Hassard thought this distance away from Toronto might be inexpedient, as it would be advisable to have it reasonably near to the University of Toronto. It would likely be built away from Yonge Street, in order to get away from railway and electrical vibrations and also from mists.

Mount Wilson Telescope.

Speaking of the telescope at Mount Wilson, Mr. Hassard said it has a diameter of 100 inches. The telescope at the Dominion Observatory at Victoria, B.C., has a diameter of 72 inches, the glass alone weighing four tons. The glass has a thickness of 14 inches, the whole being so delicately poised that it can be moved very easily. Dr. J. A. Brashear of Pittsburg, Pa., supplied the lenses and mirrors. British telescopes have also been renowned for generations.

Mr. Hassard declared that Ontario astronomers have been trying and hoping for twenty years for this great prize, made possible by Mrs. Dunlap and her son. The gift is particularly welcome at this time, because the Toronto Observatory is being dismantled. This observatory was erected in 1882 to view the transit of the planet Venus.

At the University of Toronto, Mr. Hassard continued, there is a special department for the teaching of physical and astronomical science; and, to teach the subject adequately and at first hand, it is absolutely indispensable to have something like the gift of Mrs. Dunlap and her son. For the University of Toronto department information is now obtained from observatories outside of Canada or the Dominion observatories at Victoria or at Ottawa. The telescope at the Toronto Observatory is only six inches in diameter and not fit to cope with the greater problems of the local scientists.

The telescope, such as is described in the official statement, according to Vice-Chairman Hassard will permit astronomers to view the moons of Mars, five of the satellites of Jupiter, eight at least of the satellites of Saturn, and probably astronomers might get a glance at the new planet, Pluto, discovered at Mount Wilson last year, and which is the outermost planet of the solar system.

Mr. Hassard said that Professor Chant of the University of Toronto had published a book a year ago on astronomy. This book which has had a world-wide circulation, and has been translated into at least two European languages, was dedicated to Mrs Dunlap. In this book Mr Hassard is pictured as looking through his home-made set, which has a diameter of nine inches. "Mrs. Dunlap is wholeheartedly interested in astronomy, and this explains her handsome gift," concluded Mr. Hassard.

THE GLOBE, TORONTO, THURSDAY, JANUARY 1, 1931.

A MUNIFICENT GIFT

Establishment in the neighborhood of Toronto of an astronomical observatory in connection with the university is the most important scientific announcement of recent years. It will be of inestimable value to those devoted to a study of the objects of the sciences, and will make of the city a mecca for eminent men whose chief interest is in the wonders of the astral realm. This observatory is to be built and equipped by Mrs. David A. Dunlap and her son, Mr. D. Moffat Dunlap, as a memorial to the late Mr. Dunlap, who was an ardent student of astronomy.

It will be equipped to magnificently as to rank with the greatest similar observatories anywhere in the world. The building that is to house the delicate instruments of the astronomer is to be in keeping with the nature of its duties and will stand in the midst of an extensive acreage to be devoted to park purposes. The observatory itself will be under the Department of Astronomy of the University of Toronto, while the surrounding area will be developed in a scientific way by the Faculty of Forestry.

The science of astronomy is said to have had its origin with the Chaldeans who, according to Greek historians, were able to predict eclipses with considerable accuracy. All down the centuries great names have been associated with this most interesting of the sciences. Little by little the movement of the planets has been made known by observers and with increasing knowledge the beginning and end of an eclipse may be announced to the minute. The great telescope to be installed in the Toronto observatory will it is announced, permit astronomers to view the moons of Mars, the satellites of Jupiter and of Saturn and perhaps the newly-found Pluto, the latest of the heavenly bodies to be brought within the range of human observation.

The new observatory will be a wonderful thing for Toronto, where there are many amateur astronomers, but still more valuable to the University, which then may take its place as a centre for the study of the mysteries of the starry vault above. By their munificent gift Mrs. Dunlap and her son have earned, and will have the lasting gratitude not only of the people of this city but of the whole Dominion.

Boon to Astronomers

To the Editor of The Globe. What a refreshing piece of news was reported in your issue of Dec. 30 with reference to a new telescope which will be presented to Toronto in the near future. It is not only an instrument which will be an honor to the giver, and a glorious memorial to one who, without doubt, must have many times when surveying the heavens suffered from lack of adequate means to delve into the hidden mysteries of the universe, but an instrument that will be truly an incentive for our rising generation to take up this sublime science of astronomy.

Let those of us who are not of the technical order give our whole support as much as we possibly can to bring about the best application of this splendid signature which will not only afford the professional student means of studying the higher branch of science, but we hope also ways and means will be found to the non-technical layman to acquire knowledge through this instrument and thereby bring a greater number of students studying this particular branch of science if only in an amateur way.

Birch Cliff. H. A. Robson.

MAIL & EMPIRE, DECEMBER 30, 1930

Observatory Planned for City As Memorial to D. A. Dunlap

Widow to Erect Plant With Second Largest Telescope in World.

One of the finest astronomical observatories in the world, with a giant reflecting telescope 74 inches in diameter, the second largest telescopic aperture in the world, will be erected in the vicinity of Toronto in the near future, according to an announcement made yesterday by Prof. C. A. Chant, head of the department of astronomy at the University of Toronto.

The observatory will be erected by Mrs. D. A. Dunlap and her son, D. Moffat Dunlap, as a memorial to the late David A. Dunlap, who died Oct. 24, 1924, and will be known as the "David Dunlap Observatory."

A tentative site has been selected a few miles north of the city, Prof. Chant stated. The telescope, the contract for which was given several months ago to the firm of Sir Howard Grubb, Parsons and Company, Newcastle-on-Tyne, England, will be three years in the making, Prof. Chant estimated. It would be two and one half years before the observatory is in operation. Plans have not yet been drawn, he said, and construction will not likely begin for some time.

The observatory will comprise two buildings, one a circular metal structure for the telescope and the other in classic style for offices and laboratories. There is only one telescope of greater aperture in the world than the instrument planned, that on Mount Wilson in California.

The acreage surrounding the observatory will be converted into a park which will be known as the David Dunlap park. The university's department of astronomy will have charge of the observatory, while the forestry faculty will develop the park.

Astronomy and geology were both favorite studies of the late David Dunlap, but the former had a peculiar attraction for him. The new project, Prof. Chant stated, has been under consideration for the past five years. In working out the plans Mrs. Dunlap has had the assistance of Professor Chant, one of Canada's best known astronomers.

Toronto Daily Star, Dec. 31, 1931.

Gift Observatory for Toronto Will House World's Second Largest Telescope

Star Dec. 31, 1930

MRS. DAVID DUNLAP DONATES MAGNIFICENT ASTRONOMICAL RESEARCH CENTRE AS MEMORIAL TO HUSBAND—SITE UNCERTAIN

As a memorial to her husband, late David Dunlap, Mrs. David Dunlap and her son, D Moffat Dunlap have donated a magnificent observatory to Toronto, which will house the world's second largest telescope. The Toronto telescope will be 74 inches in diameter, second only to that at Mount Wilson observatory, California, which is 100 inches. The exact site of the new observatory is, as yet, uncertain, but speculation centres about the Alcorbrack and W. G. and R. A. Marsh farms at Stop 23 Yonge St., which were purchased in 1928 for a purpose

—Photos by ... Daily Star Staff Photographers

ABOVE: ... Prof. C. A. Chant, head of the Observatory of Toronto, who ... BELOW: ... the telescope ... which will be erected in vicinity of ... donated the magnificent gift

Toronto Daily Star, Dec. 31, 1930.

DUNLAP OBSERVATORY GIFT TO UNIVERSITY

Second Largest Telescope in World To Be Erected Here as Memorial

An astronomical observatory which will rank as one of the finest in the world, and which will contain a telescope with an aperture 74 inches in diameter, the second largest in the world, will be erected in the vicinity of Toronto, in the near future, according to an announcement made yesterday by Prof. A. C. Chant, head of the department of astronomy of the University of Toronto.

Housed in a circular metal building, with offices, libraries and studies in an adjoining structure of beautiful classic architecture, the observatory will be the gift to the university of Mrs. Dunlap and her son, D. Moffat Dunlap, as a memorial to the late D. A. Dunlap, who died Oct. 29, 1924.

The observatory will be situated in the midst of a large acreage on north Yonge St., which will be converted into a park, to be known as David Dunlap Park.

The observatory will be under the control of the department of astronomy of the university, while the park will be developed by the faculty of forestry. This is considered fitting, as the late Mr. Dunlap was interested in astronomy and geology.

It is understood that the university has been hampered for some time by lack of a suitable observatory. The equipment erected in 1882 to view the transit of Venus is being demolished. Students of astronomy at the university have been relying on information derived from foreign sources, chiefly observatories in the United States, and the Dominion observatory at Ottawa. The telescope of the Toronto observatory is only six inches in diameter and quite inadequate to cope with the requirements of the students.

The contract for the new telescopic instrument for the David Dunlap observatory was let some time ago to the firm of Sir Howard Grubb, Parsons and Co., Newcastle-on-Tyne, England.

NEW OBSERVATORY FOR USE WHOLLY IN RESEARCH WORK

Mrs. Dunlap's Magnificent Gift an Outstanding Attraction to the University

SITE IS UNCERTAIN.

The magnificent gift to the University of Toronto of an astronomical observatory with the second largest reflecting telescope in the world by Mrs. Dunlap and her son, D. Moffat Dunlap, as a memorial to her husband, David Dunlap, cannot fail to be an outstanding attraction to the university for this part of the world, Prof. Clarence A. Chant indicated in an interview today.

The Toronto telescope, 74 inches in diameter, will be two inches larger in diameter than the one at the Victoria observatory in British Columbia and will have many improvements of design on this great instrument, especially in case of operation. In all general respects, the Toronto observatory and the larger telescope to be brought here will resemble the huge instrument in Victoria. One difference here will be lower walls.

In reply to questions, Dr. Chant explained that the new observatory, when it is established here, will have no connection with the Dominion government and the government meteorological department.

"Ours will be used for purely astronomical research," Dr. Chant explained, "and will be for research in connection with the university. Of course, we might make some observations to help them out in connection with weather observations."

Is Seeking Site

At this present moment, Dr. Chant was emphatic, the site of the building is entirely uncertain, except that there is a farm close to Yonge St., about ten miles north, that the University can fall back on. But, at the present moment Dr. Chant is inspecting several sites that have been brought to his attention. There is no reason, it is stated, why the building has to be located near Yonge St., although a northern site is best, since the prevailing winds that bring fine weather here are from the southwest, and they would blow the smoke and dust away from the telescope if it was located approximately ten miles north of the city, where the accessibility to the University would also be a contributory factor.

Star Dec 30/30

Science News-Letter
Washington D.C.
Jan. 10, 1931

ASTRONOMY

Another Huge Telescope Ordered for Canada

CANADA will soon have two of the world's three largest telescopes. This became known with the announcement to Science Service by Prof. C. A. Chant, head of the Department of Astronomy of the University of Toronto, that a 74-inch reflecting telescope has been ordered for the University from Sir Howard Grubb, Parson and Co., in England. Among existing telescopes, only the 100-inch reflector at the Mt. Wilson Observatory, in California, is larger. The figure refers to the diameter of the great mirror which concentrates the light of the star at which it is pointed.

According to Dr. Chant's announcement, the telescope will form the main feature of the David Dunlap Observatory.

At present Canada has the world's second largest telescope. This is a 72-inch reflector at the Dominion Astrophysical Observatory, Victoria, and it will become the third largest when the Dunlap instrument is completed. Third largest at present is the 69-inch reflector at the Perkins Observatory of Ohio Wesleyan University, Delaware, Ohio. The great mirror for this telescope, made of glass manufactured at the Bureau of Standards, Washington, is now being completed at Pittsburgh. The telescope is expected to be in operation by next summer.

Two telescopes at present share the honors for the fourth largest. The 60-inch at Mt. Wilson is tied by a 60-inch at the South African station of the Harvard College Observatory.

All of these instruments will be far surpassed in size by the 200-inch reflector now being made in southern California for the California Institute of Technology. Such an undertaking is this, however, that it will probably be several years before it is completed. Another project for a huge reflector, perhaps even bigger than 200 inches, has the backing of a group of men in Miami, Florida, but as yet no actual work has been done on it.

Science News Letter, January 10, 1931

Nature, (London Eng.)
Jan. 17, 1931

JANUARY 17, 1931] NATURE

News an

THE important announcement has just been made that in the near future there will be established in the vicinity of Toronto an astronomical observatory which will rank with the world's greatest institutions of this kind. It will be erected by Mrs. D. A. Dunlap and her son, D. Moffat Dunlap, as a memorial to the late David A. Dunlap, who died on Oct. 29, 1924, and will be known as the David Dunlap Observatory. Astronomy and geology were both favourite studies of Mr. Dunlap, but the former had a peculiar attraction for him. He was a keen student of the heavens, and always liked to share his knowledge with others. This project has been under consideration for the last five years and will now be brought to completion. In working out the plans, Mrs. Dunlap has had the assistance of Prof. C. A. Chant, head of the Department of Astronomy of the University of Toronto.

THE outstanding feature of the David Dunlap Observatory will be a large reflecting telescope seventy-four inches in diameter. There is only one of greater aperture in the world, namely, that on Mount Wilson in California. The instrument was ordered some time ago from the firm of Sir Howard Grubb, Parsons and Co., of Newcastle-on-Tyne. It will be housed in a circular metal building, such construction being best for this purpose. The observatory building will be a beautiful structure in the classic style. It will be erected on a suitable site near Toronto, in the midst of a large acreage which will be converted into a park, to be known as the David Dunlap Park. When the observatory is completed, it will be under the Department of Astronomy of the University of Toronto, while the park will be developed in a scientific way by the Faculty of Forestry. The new institution will bring distinction to the University, the city, the province, and indeed the whole Dominion. It will be an enduring memorial to a worthy citizen.

NATURE

Telegraphic Address:
PHUSIS, WESTRAND, LONDON
(Two Words).
Telephone Number:
GERRARD 8830

MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET,
LONDON, W.C.2

RAG/RG.N. 12th January, 1931.

Prof. C. A. Chant,
The University,
TORONTO, Canada.

Dear Prof. Chant,

I am very glad to have the information you have been good enough to send me relating to the Observatory which is to be established in connection with the University of Toronto by Mrs. Dunlap as a memorial to her husband. I am inserting the notes in this week's issue of "NATURE" and am sure that many readers will be interested to learn of this munificent gift.

With all good wishes for 1931,
Very sincerely yours,

D. A. Gregory

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

Vol. XXV, No. 1 JANUARY, 1931 Whole No. 200

A GREAT MEMORIAL

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The new institution will bring distinction to the university, the city, the province and indeed the whole dominion. It will be an enduring memorial to a worthy citizen.

Note.—The above announcement was made public on December 30, 1930. A great observatory in the midst of a fine park will be an appropriate memorial to the late Mr. Dunlap, and it will likewise be a splendid gift to the university and the community. Further information will be given as the project is carried out

C. A. CHANT.

From the Journal of the Royal Astronomical Society of Canada
C.A.Chant, Editor

Letter from the Editor of "Nature", See printed note on page 14

YEARS OF BRITISH TRADITION WILL ENTER NEW TELESCOPE

Regretted Sir Charles Parsons Died Before Toronto Reflector Made

A DIFFICULT TASK

By C. A. CHANT
Professor of Astro-Physics, University of Toronto

The recent death of Sir Charles Parsons while on a pleasure cruise in the West Indies recalls some interesting - and human - incidents in the history of telescope building.

Sir Charles Parsons

Charles Algernon Parsons was the youngest son of William Parsons, third Earl of Rosse, of Birr Castle, Parsonstown, Ireland. The latter was born in 1800 and succeeded to the title on his father's death in 1841. He graduated at Oxford with first class honors in mathematics. While a youth, he showed a special taste for mechanics, and developed a remarkable manual dexterity in carrying out his ideas. He loved to visit the great industrial works which were then springing up in England. On one occasion while being conducted over a large factory in the north of England, he exhibited such an intelligent interest in what he saw that the proprietor, being in need of a foreman, offered him the position. The visitor gently explained who he was; but he appreciated the compliment and the incident led to a pleasant dinner and a valued friendship.

Having leisure and means, Lord Rosse looked about for the best way to employ his mechanical ability. He admired exceedingly the work of Sir William Herschel, who became world famous through his construction of great telescopes and his skill and zeal in using them. Lord Rosse realized that the construction of mighty instruments for exploring the heavens would demand much time, much wealth and the very limit of his mechanical skill and he decided to make this the chief business of his life.

There are two types of telescopes, refractors and reflectors. In the former a lens collects the light coming from the celestial object and converges it to form the image; in the latter a concave mirror performs this function. The largest telescopes are reflectors.

Now the production of the mirror of a reflector is the most difficult and delicate part of the whole procedure and Herschel had left no details of the way he went about it. The material then used for mirrors was an alloy of copper (two parts) and tin (one part) which is very hard and brittle quite unlike either of its constituents. It is hard to cast and difficult to work but it takes a fine polish and does not tarnish easily.

Was Scientific Wonder

Lord Rosse after much experimenting, undertook to make a mirror six feet in diameter and five inches thick—far larger than any attempted up to that time. At every stage he met immense difficulties, but he overcame them all and completed his telescope in 1845. It was one of the wonders of the scientific world. It was pictured in the papers and magazines and in all the books on astronomy, and Birr Castle became a mecca to which the faithful from every country made pilgrimages. It remained unequalled in size until about 15 years ago.

Thomas Grubb was another clever Irish mechanician, also born in 1800, at Kilkenny. Early in the century he established, near Dublin, works for the manufacture of astronomical instruments, small machine tools, etc. He was original and ingenious and acquired great skill in practical optics. Among the products of his shop was the original equipment for nearly 40 magnetic stations, one of which was established in Toronto in 1840 and has been in operation ever since though removed in 1898 to Agincourt. Lord Rosse became acquainted with Grubb and frequently sought advice from him. Grubb's last and most important production was the notable four-foot reflector for Melbourne, Australia which was completed in 1867. Until quite recently it was the largest telescope in the southern hemisphere. The present writer had the pleasure of inspecting it in 1922.

Thomas Grubb retired from active work in 1868 and was succeeded by his son, Howard, who extended the business making mine instruments, large and small. In 1918 the works were moved to St Albans in Hertfordshire, England in connection with the manufacture of periscopes, as the firm had made a specialty of these instruments from the date of the first British submarine.

Devised Steam Turbine

Sir Charles Parsons now comes into the story. He was born in 1854. He received some of his education from the able young astronomers employed by his father to observe with the great six-foot telescope, and then he went to Cambridge, where he graduated in 1876. In his father's workshops he learned to love mechanical pursuits, and on leaving the university, he went as an apprentice into the Armstrong ordnance works at Elswick.

He devoted all his spare time to the study of steam and in 1884 he built a ten horse-power turbine steam engine the first practically successful engine of this kind made. It received little attention, but the inventor labored unceasingly to perfect it, and in 1889 the firm of C. A. Parsons and Co was formed to produce steam turbines and electrical equipment.

The business progressed quietly and modestly as its head was averse to spectacular advertising. However, he saw his opportunity on the occasion of Queen Victoria's Diamond Jubilee in 1897. He equipped a yacht 100 feet long and nine feet wide with turbine engines of about 2,000 horse-power, and at the naval review it raced up and down the line of warships at the unprecedented speed of nearly 40 miles an hour. Nothing further was needed. The use of the steam turbine for warships and good passenger vessels is now almost universal.

The invention and perfection of the steam turbine is by far the most important advance in steam engineering since the time of Watt.

Immense works have been established at Newcastle-on-Tyne for the manufacture of marine and stationary turbines and electrical machinery. The great Cunard ship now being built will be propelled by turbine engines of 200,000 horse-power.

Working on Toronto Reflector

In the reaction after the war, Sir Howard Grubb's firm became involved in financial difficulties, and what could be more natural than that Sir Charles Parsons should come to the rescue. There had been cordial co-operation between the fathers, why not between the sons? The firm was acquired by Sir Charles in 1925 and the name was changed to Sir Howard Grubb, Parsons and Co. Large and well-equipped shops were erected beside the electrical works at Newcastle and the firm was ready to construct astronomical equipment of the largest size.

In 1921, Sir Charles acquired what is now known as the Parsons Optical Glass Works at Derby, and thus the firm can supply its own glass for all purposes. Recently a 36-inch reflector was completed for the Royal Observatory at Edinburgh, while a 40-inch reflector and a 24-inch refractor for Stockholm are almost finished. Some work has been done on a 41-inch refractor for the Soviet government of Russia.

In May, 1930, the order was given to the firm for the immense 74-inch reflector for the David Dunlap Observatory, to be erected near Toronto. About three years will be required for its construction.

Sir Charles Parsons passed away on board ship in the harbor of Kingston, Jamaica, at the age of 76. It is to be regretted that he did not live to see Toronto's mammoth telescope completed, for while he built many commercial machines of larger dimensions and indeed was accustomed to carrying through great projects yet it is certain that he would have had special delight in producing a telescope excelling his father's historic masterpiece of 1845.

The Star Weekly (Toronto) March 31, 1931.

ROYAL YORK HOTEL
TORONTO

Canadian Pacific Hotels

May 23rd, 1931.

Mrs. D. A. Dunlap,
93 Highland Drive,
Toronto, Ont.

Dear Mrs. Dunlap:-

It was a great pleasure to me to meet you personally on Thursday night, and to express briefly then my appreciation of your magnificient gift for the advancement of Astronomy. I can assure you, for I know personally most of the eminent Astronomers of the world and their views on any addition to the facilities for prosecuting their science, that your great contribution will be highly appreciated by them and that the name of your husband and yourself will be perpetuated by such a gift and by the work done by the David Dunlap Observatory, as I think a gift to no other science could accomplish.

I recall to mind the name of James Lick who bequeathed a large sum to establish an observatory near San Francisco nearly fifty years ago. Lick was a contractor of San Francisco who would certainly have been forgotten long ago if it had not been for this gift which, wisely administered, has made the name of the Lick Observatory perhaps the most celebrated in the world. I feel sure that your generous gift, under the wise management of Professor Chant and the University, will make the name of your husband widely known, not only to all Astronomers, but to the whole world of science and culture. I wish to thank and congratulate you again as a Canadian Astronomer for your generous gift and very wise memorial.

Letter from Dr. J.S. Plaskett regarding the site chosen for the Observatory

I had the pleasure this morning of going with Professor Chant to the proposed site of the Observatory, and I was very favourably impressed with its special suitability for the purpose. The position on an eminence sloping away in every direction is particularly desirable, as the air drainage thereby produced tends to improve the "seeing" conditions materially, as well as reduce the daily range of temperature variations, also an important factor. I did not see in our journey to the spot any location at all approaching in desirability the one chosen. I believe however, it would be desirable to secure some additional land to the north so as to control the whole summit and approaches to it for at least a quarter of a mile in every direction.

May I wish you sincerely much pleasure and happiness in watching the progess of this wonderful memorial, and in following after completion the valuable work it will undoubtedly produce.

Yours sincerely,

J. S. Plaskett

Director,
Dominion Astrophysical Observatory,
Victoria, B. C.

THE ROYAL SOCIETY OF CANADA PROCEEDINGS FOR 1931

RESOLUTION REGARDING THE DAVID DUNLAP OBSERVATORY

It was moved by Dr. Plaskett, seconded by Dr. King, that the members of the Royal Society of Canada desire to express their appreciation of the notable contribution to science which is being made by Mrs. D. A. Dunlap in undertaking the erection of a well-equipped astronomical observatory, which will supply additional facilities for research to the University of Toronto

They recognize that this great observatory will be an appropriate and enduring memorial to the donor's late husband; they also believe that in the years to come it will lead to a large increase in our knowledge of the universe and will bring distinction to our country. Carried.

Resolution passed May 22, 1931

An Astronomical Observatory for Toronto

An outline of a project prepared by a committee representing the University of Toronto and the Royal Astronomical Society of Canada

UNIVERSITY OF TORONTO PRESS

201 Madison Ave.,
April 28 [illegible]

Dear Mrs. Dunlap, —

Herewith is the leaflet which I spoke to you about last evening. It was prepared in 1921 and describes the scheme we had at that time.

You will find the views I have regarding service to the people. The statistics are ten years, or more, old, but the flocking of the people to a telescope still continues. In 1931 the number of visitors to the observatory at Victoria, B.C., was 24,540, which was fewer than in previous years.

Very sincerely yours
C. A. Chant

201 Madison Ave.,
May 23, 1932

Dear Mrs. Dunlap, —

Herewith are three prints from the films exposed the other day. You can tell me what you think of them when next I see you. I enclose also a picture of Prof. & Mrs. de Sitter, which I thought you might like. It was taken at Dr. Burton's home at Weston.

Very sincerely yours
C. A. Chant

P.S. Hope this may catch you before you fly to N. Alda

At 93 Highland Ave., May 19, 1932

University of Toronto
TORONTO 5
DEPARTMENT OF ASTRONOMY

Mrs. D. A. Dunlap,
93 Highland Ave.,
Toronto 5

Professor & Mrs. W. de Sitter of Leyden Holland
Taken in Dr Burton's garden Nov 1931

HOTELS OF DISTINCTION
CANADIAN NATIONAL RAILWAYS

FROM CHATEAU LAURIER OTTAWA OTTAWA, ONT.

May 26, 1932

Dear Mrs. Dunlap, —

I am attending the meeting of the Royal Society of Canada. Sir Robert Falconer is president and gives his address this evening.

At noon Premier Bennett gave the members (about 125) a luncheon at The Country Club, and near me at the table was J. MacKenzie Bell, a geologist, who was much interested in our observatory project, and who tries to claim relationship to you. He says there are some people to whom you wish to consider yourself related. He is a charming person anyway.

I understand that extra land has been definitely secured.

I return on Saturday afternoon. Will address this to Highland Ave.

Very sincerely yours
C. A. Chant

Gothouse Bay,
July 20, 1932

Dear Mrs. Dunlap, —

I was pleased to learn that you had the children with you again, and that the excitement had not proved too much for you.

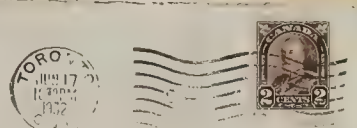
We came up here on Saturday, June 25, and have had cool weather much of the time since then. Mr. Hocken told me that the family would migrate to Shawanaga Bay on Tuesday June 28. By the way, on June 24 I got some photographs of him, several of which Mrs. Holden thinks good. I shall show you them at the first opportunity. The advertisements calling for tenders for the Administration Building had appeared before I left and the tenders were to be received up to July 11. I have not read anything further. The Property Committee of the Board of Governors was authorized to award the tender, but this was not to be done until Mr. Holden had seen

THE BOARD OF GOVERNORS,
OFFICE OF THE CHAIRMAN,
REV. CANON CODY, D.D., LL.D.

603 Jarvis St.
TORONTO, 17th June 1932

Dear Mrs. Dunlap:

The Bursar of the University has sent to Mr Holden the official acknowledgment of his letter authorizing the Board to call for tenders for the Administration Building of the Dunlap Memorial Observatory. May I add, as Chairman of the Board, our deep appreciation of your splendid generosity in this whole matter? On Wednesday morning I visited the site near Richmond Hill in company with Professor Chant and Col. Carnegie. It is magnificent. There is a natural elevation which gives an unobstructed view in all directions. The Buildings will have a commanding position and the park which will be created around them



Miss. D. A. Dunlap
Highland Ave.
Rosedale
Toronto.

HOLDEN, MURDOCH, WALTON & BEATTY

BARRISTERS & SOLICITORS

JOHN B HOLDEN K C
JAMES F MURDOCH K C
WILLIAM H BEATTY
WILLIAM S WALTON
P C FINLAY B A
S H ROBINSON B A

SUITE 603 4 ROYAL BANK BUILDING
2 & KING STREET EAST

TELEPHONE ELGIN 91
CABLE ADDRESS BARTLAW TORONTO
ADDRESS ALL CORRESPONDENCE TO THE FIRM

TORONTO 2

August 9th, 1932.

Mrs. Jessie D. Dunlap,
Mattawa,
Ont.

Dear Mrs. Dunlap:

RE OBSERVATORY:

Mr. Holden has asked us to write you and give you a report on the progress in this matter since your departure.

The deeds have now been executed by the University of Toronto and same will be registered tomorrow. The contract for the work will also be signed tomorrow.

We have also this day paid to the University of Toronto the sum of $50,000 and delivered to the University of Toronto as security for the additional payment, bonds totalling $90,000. We will not go into details in respect to the payments and bonds as we feel that you are quite familiar with all the facts.

The University will now be in a position to proceed at once with the work and Dr. Moure mentioned to the writer the fact that arrangements had been made with you and Mr. Holden that no information would be given out to the newspapers except with your approval. He also furnished us with several photostats showing the proposed Great Telescope and Administration Building and three pages of typewritten material which he states Professor Chant proposed giving to the newspapers. We understand that Professor Chant collaborated with you in the preparation of this material to be given to the newspapers, and accordingly we are forwarding same to you together with one copy of the photostat in order that you may consider same and let us know if it meets with your approval. Would you please let us have a reply by return mail.

Trusting you are having an enjoyable vacation, we remain

Yours very truly,

HOLDEN, MURDOCH, WALTON & BEATTY,

Per:

PCF/L
ENCLS.

Reduced Copy of Photostat mentioned in above Letter

THE DAVID DUNLAP OBSERVATORY

In one of the accompanying illustrations is presented the western elevation of the two chief buildings of the David Dunlap Observatory, the erection of which will be commenced soon. The Observatory is being provided as a memorial to the late David A. Dunlap by his widow, Mrs. Jessie D. Dunlap, with whom is associated their son, Mr. Moffat Dunlap. When completed it will be presented to the University of Toronto and will be conducted by the Department of Astronomy.

At the left of the picture is a circular building 61 feet in diameter, surmounted by a hemispherical dome, which can be revolved by an electric motor. The frame work is of steel. The walls are 2 feet thick and hollow, being sheathed on the inside and outside with galvanized iron. The inner and outer surfaces of the dome, also 2 feet apart, will be covered with a special kind of papiermache, and over the outer surface will be put a layer of sheet copper for protection against the weather.

This building will house a huge telescope which will be next to the largest in the world. It is of the reflecting type, that is, in place of a lens it will use a concave mirror to collect the rays of light from a star and bring them to a focus. This mirror will have a clear aperture of 74 inches and will be fashioned from a disc of glass 76 inches in diameter and 12 inches thick and weighing about 2-1/2 tons.

The telescope was ordered upwards of 2 years ago from the firm of Sir Howard Grubb, Parsons and Company, Newcastle-on-Tyne, England, and the construction is well advanced. It was estimated that the great instrument would be finished in 3 years but the final figuring of the mirror may require a longer time. The casting of such an immense block of glass, the long process of annealing, and then the grinding and polishing of its surface correct to half a millionth of an inch, sometimes takes longer than anticipated; but every effort is being made to avoid delay.

Typed Document mentioned on opposite page

continued on next page

The building is also being supplied by the same firm which is a subsidiary of Charles A. Parsons and Company, makers of steam turbines used all over the world on land and sea. It will be shipped to Toronto, it is expected, about a year hence, after it has been set up and tested in England. This summer, however, it is intended to put in the cement foundation of the building and to erect the immense pier which will carry the 50 ton telescope.

At the right of the picture is shown the Administration Building. The plans for it have been prepared by Mathers and Haldenby, Architects, Toronto. It will contain offices, library, lecture room, reception room, laboratories, computing rooms and workshop. According to the plans it will be 91 feet long by 49 feet wide, with semi-octagonal projections on each end. On the roof are three domes, those at the ends being 21 feet, that a t the centre 25 feet, in diameter. In one of the smaller domes it is proposed to mount the 19-inch reflecting telescope recently constructed at the University of Toronto by Professor R. K. Young, while, in the other small one, there will be 3 astronomical cameras on a single mounting. The chief parts of these cameras are already on hand and the mounting will be made in the Observatory workshop. In the central dome it is hoped to mount a 10-inch telescope of the refracting (or ordinary) type. This is to be used for the observation of planets, comets, occultations, and double stars; and it will also be available for public purposes.

According to the specifications the Administration Building will be constructed from Credit Valley limestone with trimmings of Queenston or Indiana stone. The plans show a beautiful square entrance hall and stairway to be finished in marble.

In the other picture is shown the proposed ground plan of the buildings. The site for them is in the midst of a 177-acre plot of land about a mile south of Richmond Hill and 1/2 a mile east of Yonge Street. This large acreage, now farmland, is to be made into a park to be known as the David Dunlap Park. It will be developed in a scientific way by the Faculty of Forestry and, in the course of years, should yield results of interest and value, besides providing a pleasant resort for the people. The dotted curves are contour lines which show the elevations above sea level. It is proposed to grade the land so that the round building will be on a circular platform 800 feet above sea level; while about 5 feet lower will be the area on which the Administration Building will be placed, and, in front of it, will be an area 3 feet lower still. These three areas will be bordered by hedges.

The great Dominion Government Observatory near Victoria, B.C., whose telescope is 72 inches in diameter, has been in operation 14 years, and has become one of the world's outstanding institutions of research. Every year it attracts scientific workers from distant lands and some 30,000 visitors make a pilgrimage to it. The David Dunlap Observatory hopes, also, to make contributions of permanent value to astronomical science and to bring distinction to the University and the Country.

Copy

September 17, 1931

Dear Mr. Holden,

Last evening I went out to Don-Alda Farm and had a long conversation with Mrs Dunlap and Moffat. I showed them about a dozen photographs of the new telescope, which afford a visual proof of the progress outlined in the last quarterly statement from the firm. I should like to show them to you if it should be convenient and you would wish it.

We also discussed what could be done to help along our project, and though we realized that the actual construction is a considerable way off, we all hoped that the ceremony of turning the sod or laying the corner stone might take place before Sir Robert Falconer retires from the presidency (July 1, 1932).

I mentioned the proposal which Mrs. Dunlap had made some time ago, namely, that the University be asked to undertake the construction. She thinks this would relieve her of much worry; and I assured her that if this arrangement was made the University would do nothing of importance without her full approval. Supt. LePan has the staff and they have had the experience which would allow the work to be carried on efficiently and without any "extras".

Then we talked about an architect. Mrs. Dunlap did not wish to name anyone. Moffat suggested Paisley, who was architect for St. Andrew's College, but his mother and I felt inclined to accept LePan's responsible suggestion of the firm of Mathers and Haldenby, which he had found very satisfactory. Even though construction cannot begin for a long time, it seems to me that the only way to make progress is to choose the architect and thus have some authoritative person to

h. Months will be required before the plans
ect Young and I may have to visit some
r to get suggestions regarding the best
ulties. Mrs. Dunlap shares my views on
nk any unreasonable obligation will be in-
tact, even though construction is delayed,
objection to the proposal.
can take time to look at the photographs
ased to take them to you, either in the
.
ardon me for bothering you. It is my sincere
al rest and speedily recover your usual

Very sincerely yours

A.C.Lent

Toronto
ITRONOMY

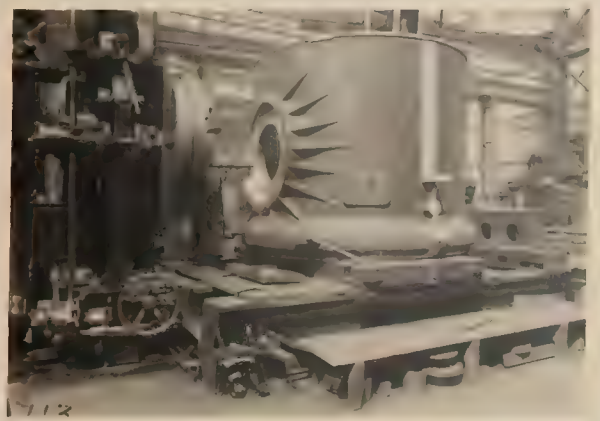
Mrs. D.A.Dunlap,
Don-Alda Farm,
TODMORDEN,
Ont.

Copy of Letter to Mr HOLDEN discussing Architects and the Progress of the Telescope

In the pages following are Photographs illustrating the construction of the 74-inch Telescope

No 12

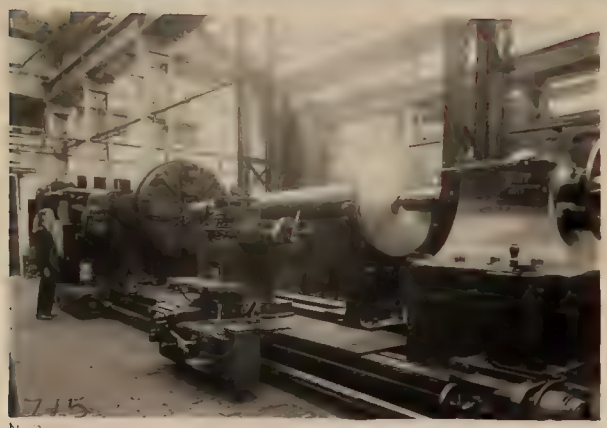
Boring out the Centrepiece of the Tube. April 1931



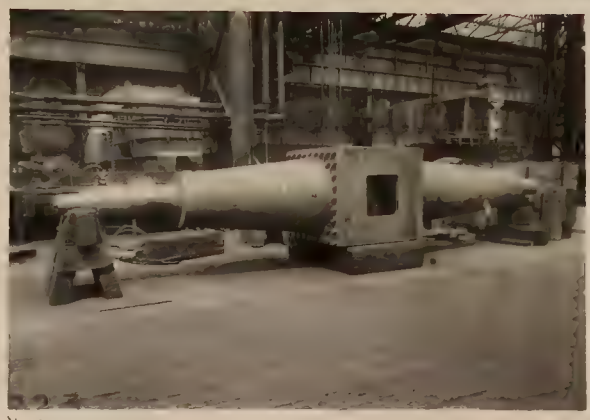
No 13

Machining the facing on the Centrepiece in the Kerr's Machine May 1931

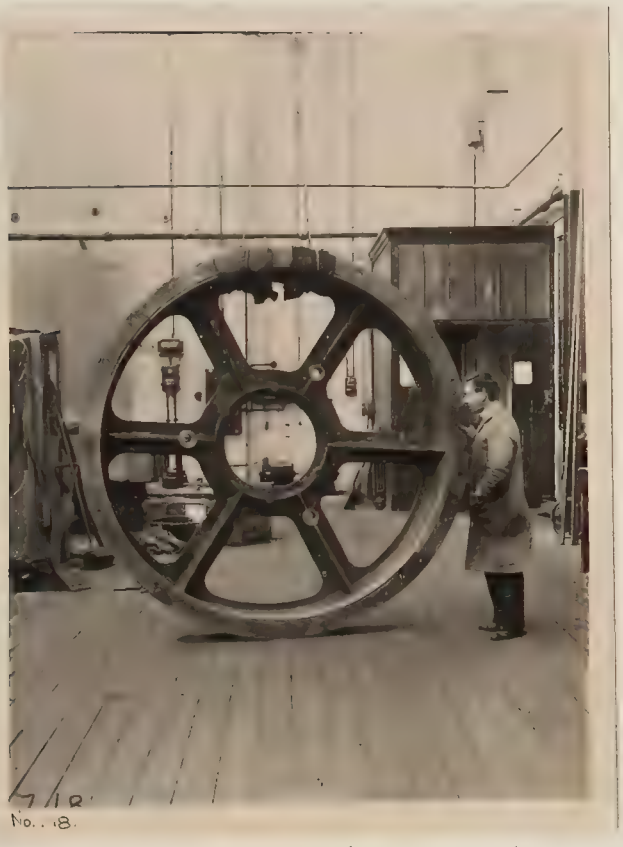
Outside diameter, 8ft. 7in., Length, 6ft. 9in., Weight 4½ tons



Turning the Declination Axis - May 1931



The Polar Axis assembled in the Shops - July 1931



Cast Steel Cell for the Main Mirror - June 1930

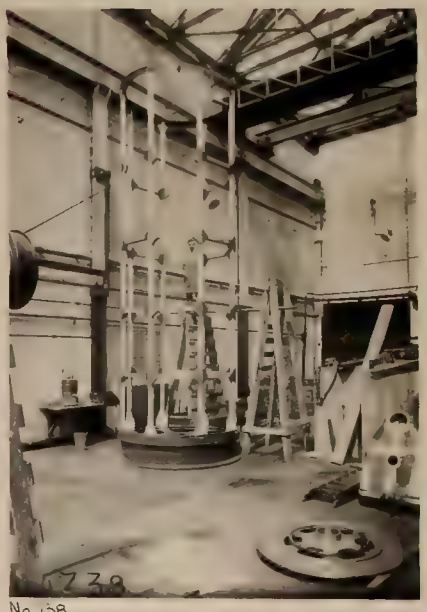
The Declination Axis fitted to the Centrepiece July 1931

No. 736.

Boring the Bush of the Sidereal Circle - August 1931

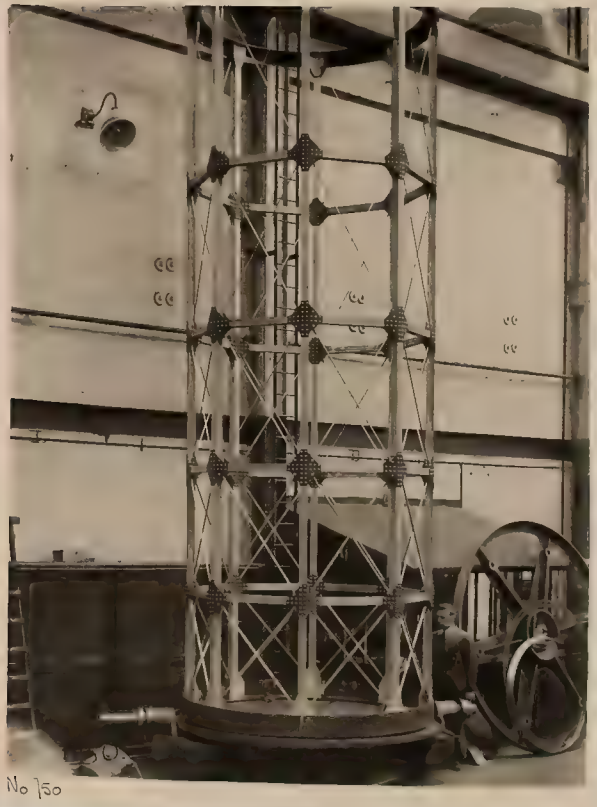
No. 734

Model of the 74 inch Telescope and Dome November 1931



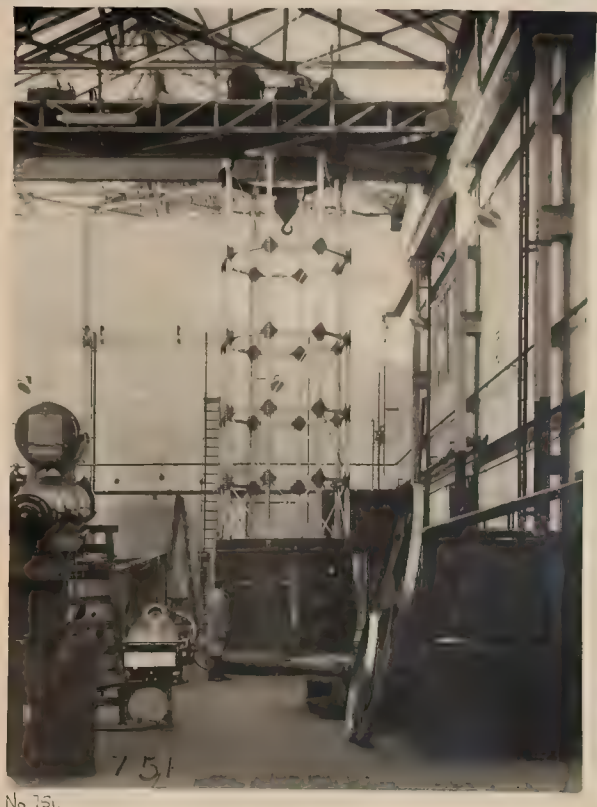
No 738.

Constructing the Lattice Tube — August 1931 (Note size from Workman)



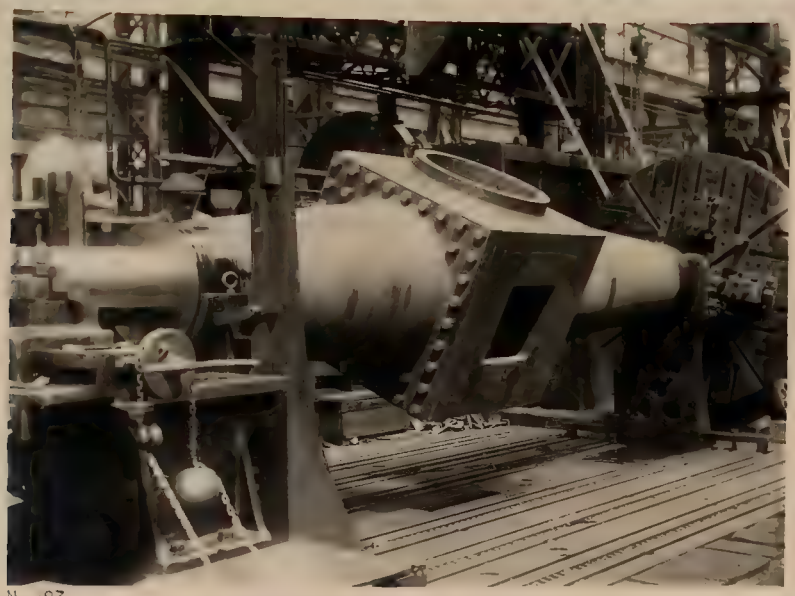
No 730

The Completed Tube, Sidereal Circle at Right October 1931



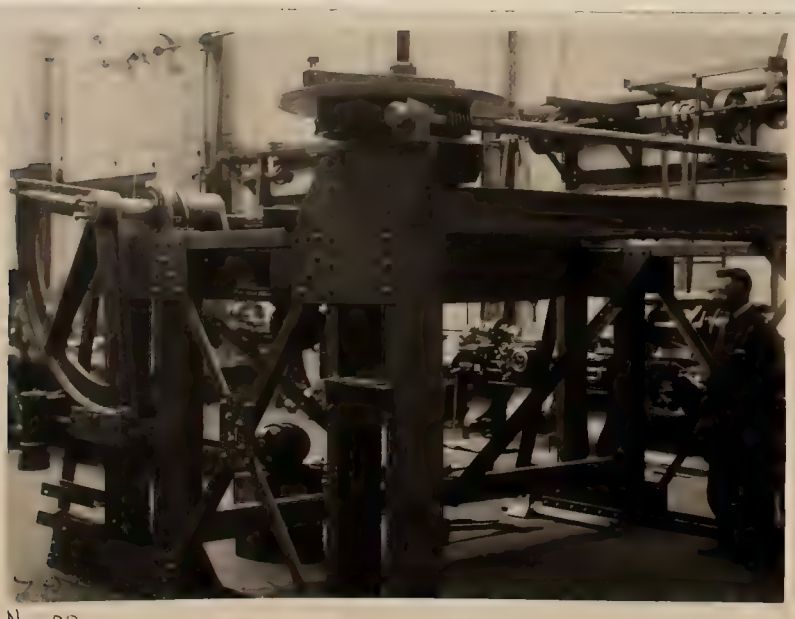
No 731.

The Tube Mounted on Centrepiece - October 1931



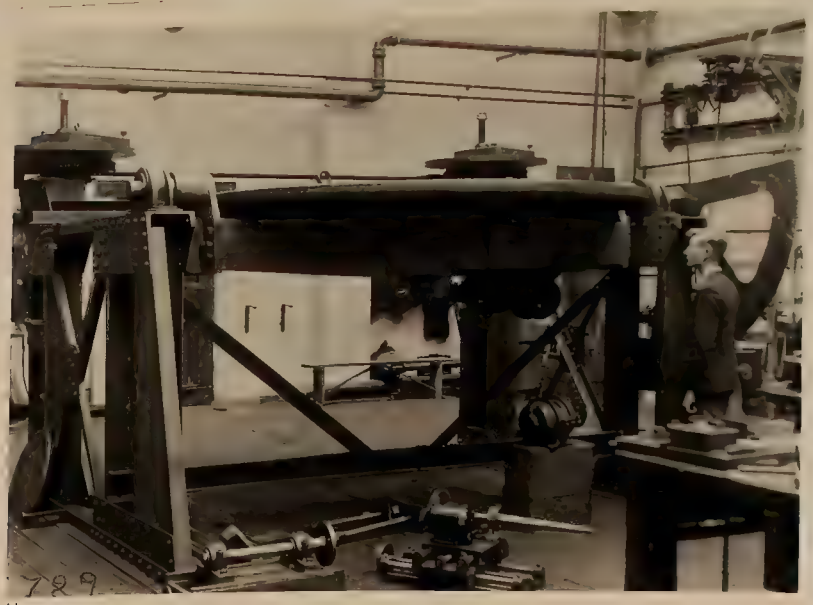
No. 127.

Turning the Polar Axis, Weight about 10 tons July 1931
(See page 22)



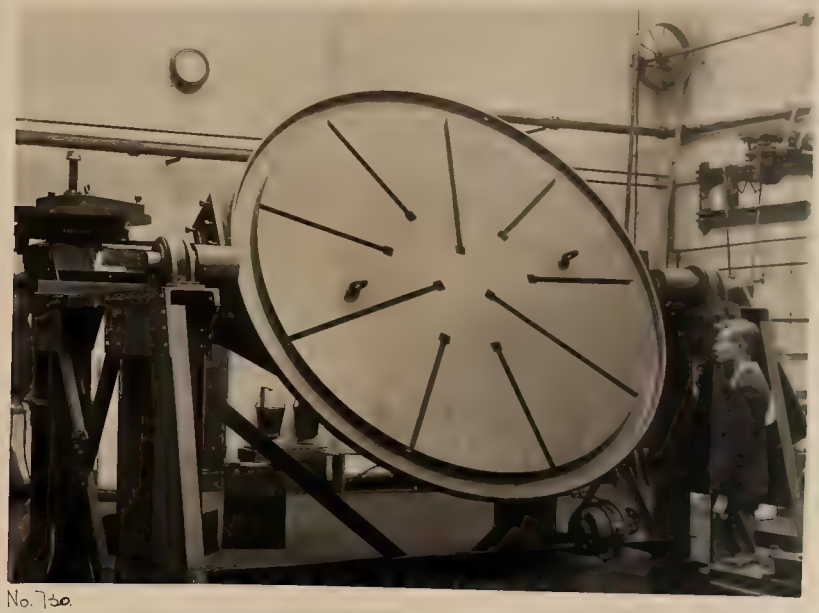
No. 128.

The Machine for grinding, polishing and Testing the great Mirror, Rear View showing the cranks August 1931



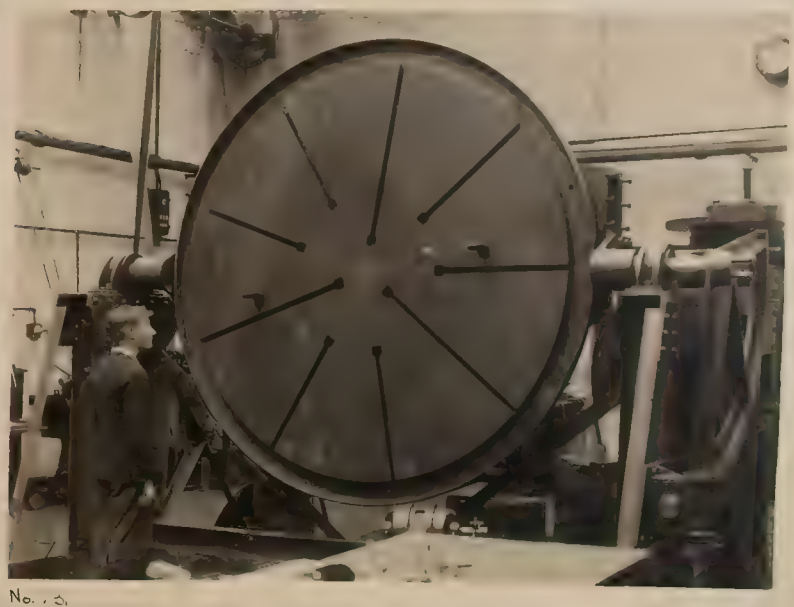
No 729

Machine for working the Great Mirror, view from front, table horizontal - August 1931



No. 730.

The same machine with table tilted - August 1931



No. 731.

The same machine, with table vertical, - August 1931

No. 786.

Turning the Driving Circle in the bathe – October 1931

No. 786

Gashing the Driving Circle, view from behind cutter gear - February 1932

No 18.

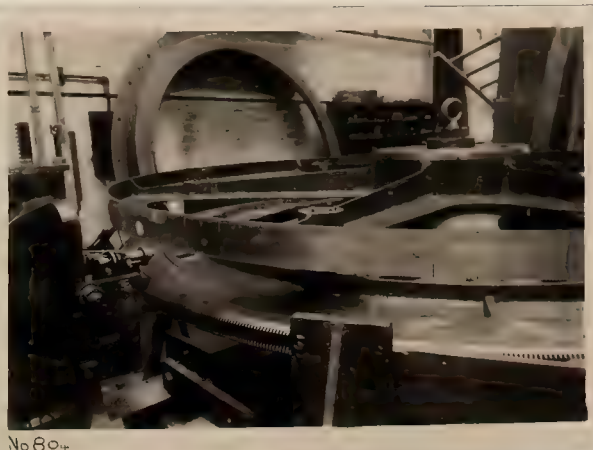
Gashing the Driving Circle, side view February 1932

No 788

Gashing the Driving Circle, close up view showing the hob – February 1932

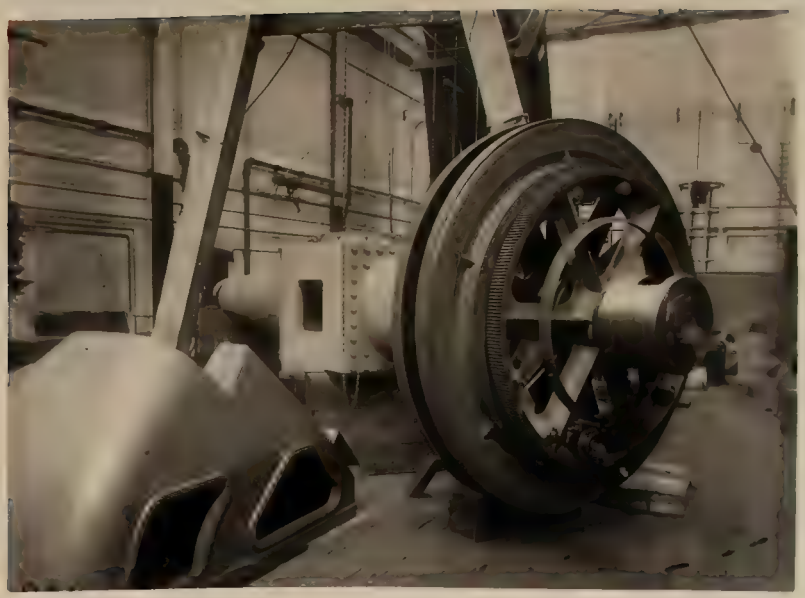
No 802

Graduating the Sidereal Circle, using the driving circle as master - February 1932



No 801

Graduating the Sidereal Circle, near view February 1932



No. 822.

Polar Axis complete with circles, ready for hoisting into place, close up view ~ May 1932

No 824.

Polar Axis, ready for hoisting into place; view from S.E. showing shear legs, May 1932

No 825

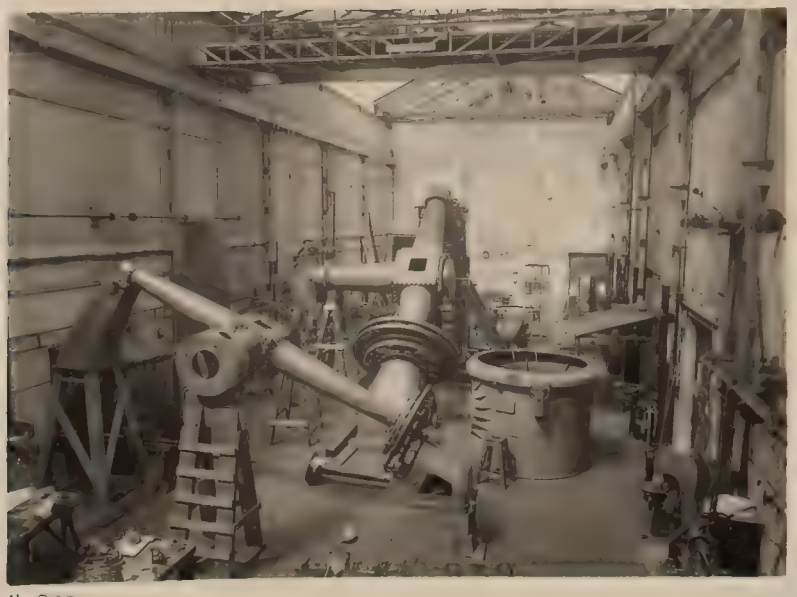
Polar Axis being hoisted into place, the lift just commencing ~ May 1932

No. 827

Hoisting Polar Axis into place, top ready for lowering – May 1932

No. 828.

Hoisting Polar Axis into place; lowering the Axis – May 1932



No 839

General view in shops, showing polar axis in place and declination axis fitted, centrepiece at right. The polar axis on its stand in front is for the twin 16-inch astrographic telescope for Leyden University – June 1932

No 849

Inserting Declination Axis; axis entered - August 1932

No 851

Inserting Declination Axis; axis home - August 1932

Moffat Dunlap, C.A. Chant, Mrs. Dunlap.
Eclipse Camp, St. Alexis des Monts, Quebec August 31, 1932

While the construction of the Telescope and dome was proceeding in England preparations for the erection of the buildings were going forward at home.

★ ★ ★

From the Journal of the Royal Astronomical Society of Canada, July-August issue Page 277.

THE DAVID DUNLAP OBSERVATORY

This great project is going forward steadily. The 74-inch reflector was ordered in May, 1930, and its mounting is well advanced towards completion. The contract for the 61-foot dome to cover it was given in November, 1931, and rapid progress is being made on it. Tenders for the erection of the Administration Building have been invited by advertisement in the press and construction will proceed actively during the summer.

★ ★ ★

There was a total eclipse of the sun on August 31, and an expedition had gone from the University of Toronto to St. Alexis des Monts P.Q. to observe it

St. Alexis des Monts, P.Q.,
August 14, 1932

Dear Mrs. Dunlap, —

I thought I would let you know how our eclipse preparations are proceeding.

Dr. Young and I drove from Toronto on Aug. 12, arriving here at 4 p.m. We stopped over at Cornwall & the road was pleasant.

On arrival we went to Hotel Boulanger where we were expected. It is a modest place, not many frills, but we are thriving. The work is going well. Dr. Young's brother Albert & son (a young man) came a few days earlier. The family rented a cottage at Lac Caché, 5 miles away. Then Mr. & Mrs. Herring arrived by motor on Sunday afternoon. The men are excellent workers and the apparatus and their houses are almost created. Quite a show!

On the 23rd three more men come to rehearse the programme & on the 25th Mr. Chant comes by motor from St. Paulin. They will all be at the hotel. Immediately

From C.A. Chant
St. Alexis des Monts,
P.Q.

Mrs. D. A. Dunlap,

Mattawa P.O.,

Ont.

at Alexis des Monts, P.Q.
August 13, 32.

Dear Mrs. Dunlap.

Just a line to [illegible] formation about this place. Yesterday I had the opportunity to visit a little [illegible] Lac Ouareau. It is from the village and found there an excellent summer hotel built [illegible] a year ago. It is called Le Chalet. In my last letter I was [illegible] the [illegible] about accommodation would be but if you can make it convenient to stay over one week will be so much of a pleasant place to stay at and the rates are very reasonable too.

If you can [illegible] St. Paulin Mr. [illegible] would [illegible] and bring you up. Lou and Eng'lin would like

President's Office.
The Hon. and Rev. D. J. Cody, D.D., LL.D.
President

[illegible] April, 1 [illegible].

Mrs. D. A. Dunlap,
93 Highland [illegible],
Toronto.

Dear Mrs. Dunlap:

I [illegible] contractor is well under [illegible] Administration Building or [illegible]. We feel here that it [illegible] there should be a formal [illegible] at an early date before [illegible] Oxford. [illegible] I hope that it will [illegible] you yourself or [illegible] over person [illegible]

[illegible] that everything [illegible] by [illegible] September. [illegible] say to three o'clock [illegible] If all this [illegible] cards of invitation [illegible] to the members [illegible] whom you wish to [illegible] would send us a list. [illegible] would like very much [illegible] or Mr. Mulder or [illegible] feel strongly that [illegible] proper public [illegible]

[illegible]

Yours [illegible],

H. J. Cody

President.

Eclipse Camp, St. Alexis des Monts.

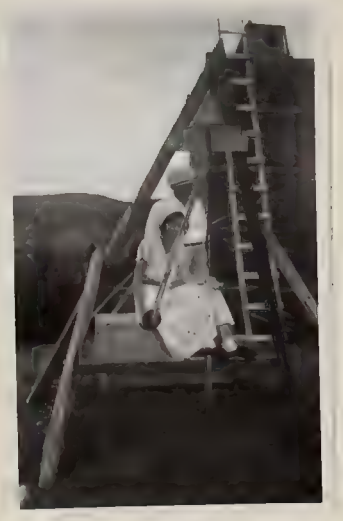
Mrs. Dunlap visited the eclipse camp, having driven from Montreal, accompanied by Moffat and Mr. Fromings.

St. Alexis from Eclipse Hill, looking east.

The Eclipse Camp, Aug. 11.

The 40-foot Camera, Aug. 18.

Mrs. Dunlap and Moffat, in front of "Chateau Einstein"



Jean Young Counting Seconds (Professor Burton behind)

Dr. Young explaining the Movie Outfit. Dr. Young, Mr. Fromings, Mrs. Dunlap, Mrs. Chant, Moffat.

Mrs. Chant and her Shadow Bands Sheet. Aug. 31

F. W. Burton, Mrs. Dunlap, Moffat, Professor Burton, Mr. Fromings and Mrs. L. V. King, beside the sheet. Aug. 31.

Nov. 12, 1932

Dear Mrs. Dunlap, —

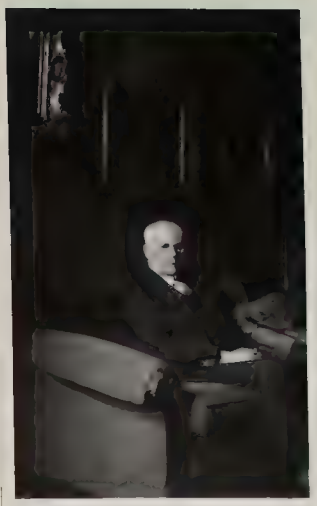
Herewith are prints from the negatives you chose. An enlargement of that one of Mr. Holden in his library will be ready shortly.

see opposite page.

Very sincerely yours

C. A. Chant

P.S. I was at the Observatory this morning (Saturday) and got another roll of films. c.a.c.



In Library.

At Sun Porch.

Mr. John Holden, at 7 Thornwood Rd. Toronto, June 24, 1932.

INTERNATIONAL ASTRONOMICAL UNION

FOURTH GENERAL ASSEMBLY

CAMBRIDGE, U.S.A. SEPTEMBER 2-9, 1932

September 5, 1932

Dear Mrs. Dunlap, —

I suppose you reached Montreal safely on Wednesday evening and then went on to Toronto. Mrs. Chant and I left St. Alexis on Thursday at 2 p.m. and drove to Montreal with Mr. & Mrs. Herring. At 8.20 p.m. we boarded the train for Boston and reached this place at 9 a.m. Friday morning. We are staying in Eliot Hall, one of the Radcliffe College dormitories, and a pleasant place it is. Radcliffe, as you know, is the women's college in connection with Harvard.

There is a large attendance of members of the I.A.U. I posted to you the programme of the meeting as well as a booklet describing the Harvard Observatory. I have met many of my old friends & made some new ones.

Yesterday afternoon we drove to Oak Ridge, 25 mi. N.W., to the new station of Harvard Observatory, and had a pic nic supper in the woods — but it was not as satisfactory a pic nic as we have on the rocks of Georgian Bay. The "corner brick" was laid by Sir Frank Dyson, a copper

(one)

HARVARD COLLEGE OBSERVATORY
CAMBRIDGE

Dr. and Mrs. Harlow Shapley would be happy to have you attend the Garden Party at the Observatory on Saturday afternoon, September third, from four to six, and join the excursion of the International Astronomical Union to the Observatory station on Oak Ridge on Sunday afternoon, September fourth.

To Mrs. D. L. Dunlap
93 Highland Avenue
Toronto, Ontario

The Journal of the Royal Astronomical Society of Canada. September, 1932

THE DAVID DUNLAP OBSERVATORY

By C. A. Chant

(With Plates IV and V)

IN Plate IV is shown the western elevation of the two chief buildings of the David Dunlap Observatory, the erection of which will commence immediately. As already stated in this JOURNAL, it is being provided as a memorial to the late David A. Dunlap by his widow, Mrs. Jessie D. Dunlap, with whom is associated their son, Mr. Moffat Dunlap. When completed it will be presented to the University of Toronto, and will be conducted by the Department of Astronomy.

The circular building at the left, surmounted by a dome, is 61 feet in diameter. The framework is of steel with hollow walls two feet thick, sheathed inside and outside with galvanized iron. The inner and outer surfaces of the dome will be covered with a special kind of papiermache, with sheet copper on the outside. This building will house the 74-inch reflecting telescope which was ordered in May, 1930, from Sir Howard Grubb, Parsons and Co., of Newcastle-on-Tyne, England. The mounting is almost completed, but the date when the large mirror will be ready is uncertain. Every effort is being made to prevent undue delay. The dome is being supplied by the same firm and is almost completed.

The Administration Building is shown at the right. The plans for it have been prepared by Mathers and Haldenby, Architects, Toronto, and the contract for its erection has been awarded to Sullivan and Fried, a Toronto company. It will contain offices, library, lecture room, reception room, laboratories, computing rooms and workshop. It will be 91 feet long by 49 feet wide, with a semi-octagonal projection on each end. The two end domes are 21 feet, the centre one 25 feet, in diameter. In one of the smaller domes will be mounted the 19-inch reflecting telescope constructed at the University by Prof. R. K. Young, while in the other will be three astronomical cameras on a single mounting. The chief parts of these cameras are already on hand and the mounting will be made in the observatory workshop. In the central dome it is intended to place a 10-inch refractor, which will be used for the observation of planets, comets, occultations, and double stars, and will also be available for public purposes.

The Administration Building will be constructed of Credit Valley limestone with trimmings of Queenston stone, while the square entrance hall and stairway will be finished in travertine.

In Plate V is shown the ground plan of the buildings. They will be located in the midst of a 177-acre plot of land near the village of Richmond Hill, about twelve miles north of Toronto. This large acreage, now farmland, is to be made into a park to be known as the David Dunlap Park. It will be developed in a scientific way by the Faculty of Forestry. The dotted contour lines show the elevation above sea-level. The great dome will be on a platform 800 feet above the sea, on an area five feet lower the Administration Building will be placed, and in front of the latter will be an area three feet lower still. These areas will be bordered with hedges, and decorated with shrubs and flowers.

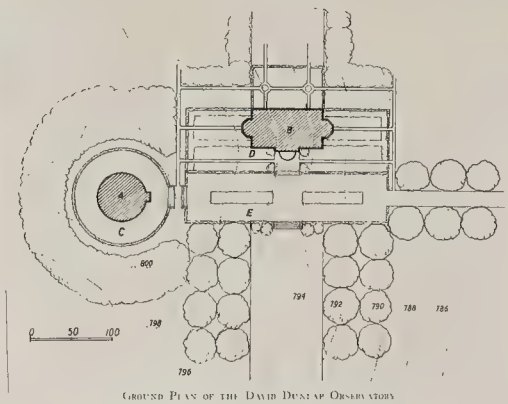
PLATE IV

THE DAVID DUNLAP OBSERVATORY

The above picture, from a drawing supplied by the architects, shows the western elevation of the David Dunlap Observatory, construction of which will begin immediately. The dome at the left as 61 feet in diameter and will cover the 74-inch reflector. The Administration Building, at the right, will be 91 feet long by 49 feet wide, with semi-octagonal projection at the ends. The building will be erected with Credit Valley limestone. In one of the smaller domes will be mounted a 19-inch reflector, on the other a battery of photographic telescopes, and in the centre dome will be a 10-inch refractor.

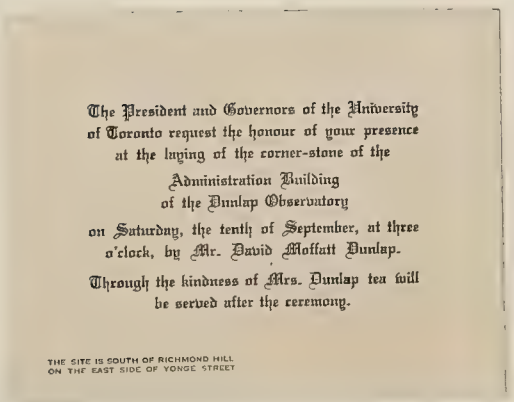
Journal of the Royal Astronomical Society of Canada 1932

PLATE V.



GROUND PLAN OF THE DAVID DUNLAP OBSERVATORY

A is the 61-foot building for the great reflector, on a platform C which is 800 feet above sea-level. On the area E, 795 feet in elevation, is the Administration Building B. The area F has an elevation of 792 feet. The dotted contour lines show the present elevations. The hill falls away in all directions, the summit being about 75 feet above the surrounding country.



The President and Governors of the University of Toronto request the honour of your presence at the laying of the corner-stone of the

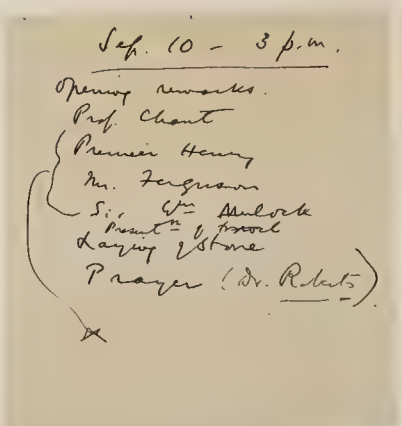
Administration Building of the Dunlap Observatory

on Saturday, the tenth of September, at three o'clock, by Mr. David Moffatt Dunlap.

Through the kindness of Mrs. Dunlap tea will be served after the ceremony.

THE SITE IS SOUTH OF RICHMOND HILL ON THE EAST SIDE OF YONGE STREET

Invitation Card to the Laying of the Corner-Stone.



Sept. 10 – 3 p.m.

Opening remarks.
Prof. Chant
Premier Henry
Mr. Ferguson
Sir Chas. Starkey
Present Mr. Moffat
Laying Stone
Prayer (Dr. Roberts)

Order of Proceedings, in President Cody's Handwriting

At the Laying of the Corner-Stone - September 10, 1932

President Cody Addressing the Gathering.

2. President Cody
4. Sir W. Mulock
5. Mrs. John G. Moore
7. Miss Montgomery
8. Mrs. Frank Cochrane
9. Mrs. T. Mc Kenzie
10. Mrs. D. A. Dunlap
11. Dr. D. B. Macdonald
12. Mr. Justice Kelly
13. Mrs. G. H. Ferguson
14. C. A. Chant
15. Mrs. G. S. Henry
16. Mrs. H. D. Warren
17. Mrs. D. M. Dunlap
18. Premier G. S. Henry
19. Mrs. F. N. G. Stuff

1. E. W. Haldenby
3. President Cody
6. Frank Cochrane
7. Alice Cochrane
8. Dr. D. B. Macdonald
9. John G. Moore
10. Sir F. Stupart
12. Mrs. D. A. Dunlap
13. Mrs. J. F. Ingles
16. Miss Montgomery
17. Mrs. G. H. Ferguson
18. Mrs. T. Mc Kenzie
19. Mrs. W. D. Ross
20. Mrs. G. S. Henry
21. Mr. Justice Kelly
22. C. A. Chant

Mrs. Dunlap presenting the Deed to Dr. Bruce Macdonald.

The Corner-Stone (with Copper Box on it) before being laid.

President Cody David Moffat Dunlap E.W. Haldenby

Mr. E.W. Haldenby presented a silver-Trowel to Moffat Dunlap who laid the Corner-stone and said:

To the glory of God
and in honoured memory
of My Father,
David Alexander Dunlap,
I lay this corner-stone.

Wilson (Stonecutter) President Cody D.M. Dunlap

Premier Henry Addressing the Gathering.

1. President Cody
2. Dr. D.B. Macdonald
3. Premier Henry
5. Dr. W.A. Parks
6. Alice Cochrane
8. John S. Moore
9. Sir W. Mulock
11. Mrs. Edward Dunlop
12. Mrs. John S. Moore
13. Mrs. Frank Cochrane
15. Mr. Mac Donell
16. Miss Montgomery
17. Mrs. D.A. Dunlap
18. Mrs. D.B. Macdonald
19. Mrs. T. Mc Kenzie
20. Mrs. G.H. Ferguson
21. Mr. Justice Kelly
22. C.A. Chant
23. Mrs. W.D. Ross

Sir William Muloch Speaking.

1. Mr Moffat Dunlop
2. President Cody
3. Sir W. Muloch
4. Dr. D. B. Macdonald
5. Miss Ingles
6. S. H. Ferguson
7. Miss Mary Dunlop
8. W. J. Dunlop

Justice Kelly

Mrs. D. B. Macdonald

Mrs. Dunlop

Mrs. S. H. Ferguson

After the Ceremony - going to the Refreshment Tent.

1. A. D Le Pan
2. Mrs. Mavis Budd
3. Mrs Williams
4. Doris Dobson
6. Mrs. H. D Warren
7. Dr. F N. S. Starr
8. Mrs D. A. Dunlap
11. Mrs. S H Ferguson
13. S H Ferguson
15. W A Wright
16. D R Rees
17. Dr D B Macdonald
20. Rev L. S Sackett
22. Dr F W Merchant
24. Leo Ramsay

Trees A, B, C were later removed for the St at Home

81 Glengowan Road
Lawrence Park
Oct Sept 10 1932

Dear Mr Dunlap

It is a matter of deep regret that I am unable be present today at the laying of the corner-Stone of the Observatory But I wish to say that I regard the occasion as being one of the highest importance not only for the University of Toronto but for the advancement of Sciences My earnest hope & strong expectation are that the Observatory will be a centre from which there will issue such researches framed in the most efficient manner, and that from it there will be announced from time to time discoveries and astronomical facts of primary value

From Sir Robert Falconer.

THE MAIL AND EMPIRE,
TORONTO, MONDAY, SEPTEMBER 12, 1932.

Lay Corner-Stone of Dunlap Observatory

Prominent figures in the laying of the corner-stone on Saturday of the Dunlap Observatory, which will contain the second largest telescope in the world, are shown here. Above is Moffat Dunlap laying the corner-stone with a silver trowel, and on the left is Dr. H. J. Cody, president of the University of Toronto. Below is Dr. J. Bruce Macdonald, new chairman of the board of governors of the university, and on the right is Mrs. D. A. Dunlap, donor of the observatory in memory of her husband.

. Sirs All ladies of the Corporation of the City of Toronto on the magnificent gift to the City of Toronto of Mr Chevalier Mayor.

From the Mayor and City Clerk of Toronto.

★ ★ ★

The Evening Telegram, September 12, 1934

"THE OLD GUARD"

WHEN THE CORNERSTONE OF DUNLAP OBSERVATORY, University of Toronto, was laid at Richmond Hill Saturday there were assembled on the same platform Hon. G. Howard Ferguson, High Commissioner for Canada in London, Dr. H. J. Cody, president of the University of Toronto, and Professor J. A. Pearce, professor of astronomy. Then as undergraduates cerebral discomforts gave them prominence and cast them together, for the three were officials of University College Literary and Scientific Society in 1898-9. The photographs show, left to right, Messrs. Ferguson (secretary), Cody (1st vice-president), and Pearce (councillor), of those days in their undergraduate gamut.

THE TORONTO DAILY STAR, SATURDAY, SEPTEMBER 10, 1932

LAY CORNER-STONE FOR DUNLAP OBSERVATORY

Leaders of the local members of Richmond Hill, in Ontario, are seen in the group who attended the laying of the corner-stone of the Administration building of the David Dunlap observatory, a mile southeast of Richmond Hill. In Ontario are seen David Moffat Dunlap, only son of Mrs. Dunlap the benefactor, and the late David Dunlap, and Sir William Mulock, chancellor of the University of Toronto who presided the gift on behalf of the university. In (2) appear Mrs. Dunlap and in (3) her daughter-in-law Mrs. D. M. Dunlap. David Moffat Dunlap laid the corner-stone.

The Hon. and Rev. H. J. Cody, D.D., LL.D.
President

September 13, 1932

My dear Mrs. Dunlap:

I thought that perhaps you would like to have a copy of the prayer that I used on the occasion of the laying of the corner-stone by your son, Moffat, last Saturday. Everything combined, I think, to make that ceremony a success, and all who were present were thrilled with the prospective magnitude of the gift, and with its meaning for astronomical science throughout the world.

With all good wishes, sincerely yours,

H. J. Cody

President.

Mrs. D. A. Dunlap,
93 Highlands Avenue,
Toronto.

University of Toronto
PRESIDENT'S OFFICE

Except the Lord build the house their labour is but lost that build it.

O God who hast given Thy Son Jesus Christ to be the one foundation and the Chief Corner-Stone; Bless what we have now done in laying this stone in Thy name and in loving memory of Thy Servant, David Alexander Dunlap. Be Thou the beginning, the increase and the consummation of this work. O Thou whose glory the heavens declare and whose handiwork the firmament sheweth, illumine the minds of those who here seek to know the laws of Thy universe and to think Thy thoughts after Thee, that the knowledge of Thy will and ways may grow from more to more and that reverence and truth may flourish and abound. Give Thy blessing to the Universities and Colleges of our land, and especially to the University of Toronto, and grant that all who teach and all who learn therein may in humility of heart look ever upward unto Thee, who art the fountain of all wisdom, through Jesus Christ our Lord. Amen.

THE OLD GUARD

After all these years, to borrow a favorite expression, the eminent trio shown here were gathered on a common platform at Richmond Hill on Saturday at the ceremony of the corner-stone laying of the Dunlap Observatory. In 1888 they were officers of the University College Literary and Scientific Society. Now they are, LEFT to RIGHT, with the youthful photos below each. Hon. G. Howard Ferguson, High Commissioner for Canada in London, then secretary of the society; Professor C. A. Chant, professor of astro-physics and then a councillor, and Dr. H. J. Cody, president of the University of Toronto, and then first vice-president.

Toronto Daily Star. Sept. 12, 1932

EDUCATION OWES A DEBT TO THE DUNLAPS.

The corner-stone of the David A. Dunlap Memorial Observatory is to be laid this afternoon by the son, Mr. Moffatt Dunlap. The ceremony is to take place under the aegis of the University of Toronto, and its president, Hon. Dr. H. J. Cody, and is to include addresses by Sir William Mulock, Administrator of the province; Premier Henry, Hon. G. Howard Ferguson and Prof. C. A. Chant, the well known astronomer.

This memorial to a Toronto philanthropist, whose intense interest in the University of Toronto, and especially in the research work of that institution, is well known, and was made possible through a gift of at least $500,000 by his widow, Mrs. Jessie D. Dunlap, whose personal philanthropy in educational and welfare work is worthy of emulation. Situated in the David A. Dunlap Park, a 177-acre site in the vicinity of Richmond Hill, the observatory is to have perhaps the largest and finest telescope on the continent, the product of a celebrated English firm. The administration building is to cost $125,000.

It will be recalled that this is but one of the generous gifts to the University by Mrs. Dunlap and the late Mr. Dunlap, who donated valuable apparatus to the department of psychology. Various scholarships have been contributed by them. The University has benefitted largely through Mr. Dunlap's will, and since his death through the practical interest shown by his widow.

Mail and Empire Sept. 10, 1932

GIANT OBSERVATORY CORNER-STONE LAID

Magnificent Gift to University Reaches Another Stage

(Special Despatch to The Globe)

Richmond Hill, Sept. 11.—Accepting a silver trowel from Eric Haldenby, architect of the new observatory to be erected for the University of Toronto, at Richmond Hill, David Moffat Dunlap yesterday placed the foundation stone in position, and thus paved the way for the construction of the magnificent administration office, which will be erected to the memory of his father, the late D. A. Dunlap, for whom it will be named.

In his opening remarks, Rev. Dr. H. J. Cody, President of the University of Toronto, referred to the great benefits which had been secured for the university through the generosity of private benefaction and told of the interest which the late Mr. Dunlap had taken in the study of astronomy during his lifetime. He commended the enterprise of a son who, he said, was said to excel.

Professor C. A. Chant told how the first thought of erecting the observatory dated back to 1921. In addition to housing the second largest telescope in the world, Professor Chant said that three smaller instruments would also be placed in the building these to be completely installed by next summer.

Premier G. S. Henry on behalf of the Province, expressed appreciation of the gift, and announced the appointment of Dr. D. Bruce McDonald as Chairman of the Board of Governors of the University of Toronto to succeed Dr. Cody.

Hon. G. Howard Ferguson, High Commissioner to Britain, added his congratulations, and declared that although no longer directly associated with the university, he was profoundly interested in its progress and achievement. With a twinkle in his eye he added: "My interest is as great as the greater because of my being so far away. I'm sometimes nervous about what they might be doing."

Sir William Mulock paid a deep tribute to Mrs. Dunlap for the way in which she had chosen to associate the name of her husband with the advance of education in the Province. Following the ceremony the guests were entertained in a huge marquee and were served with tea by Mrs. Dunlap, who presided as hostess.

Observatory at Richmond Hill

DETAILS of the erection of a mile south of Richmond Hill of the second largest telescope in the world—at an estimated cost of $500,000— a memorial to the late David A. Dunlap by his widow, Mrs. Jessie D. Dunlap, were made public recently.

Work on the administration building, one of the two chief buildings being erected as part of the David Dunlap Observatory, will start immediately, officials of the University of Toronto said. The administration building costs in the neighborhood of $125,000 while the greater part of the cost is involved in the erection of a circular building 61 ft. in diameter to house the huge telescope, virtually all of which is now being constructed in England. The mirror alone weighs 5,000 lb.

The two buildings will be located in the centre of a 177-acre plot of land a mile south of Richmond Hill and half a mile east of Yonge St. in Markham township. The acreage now farmland, will be made into a park to be known as the David Dunlap Park.

The round building will be on a circular platform 800 ft. above sea level while the administration building will be on a level five ft. below and in front of it will be an area three ft. lower still.

The telescope, larger than the one in the Dominion Government observatory at Victoria, B.C., is of the reflecting type, that is, in place of a lens it will use a concave mirror to collect the rays of light from a star and bring them to a focus. This mirror will have a clear aperture of 74 in., and will be fashioned from a disc of glass 76 in. in diameter and 12 in. thick.

Globe. Sept. 12.

The telescope was ordered more than two years ago from the firm of Sir Howard Grubb, Parsons & Company, Newcastle-on-Tyne, England, and the construction is well advanced. It was estimated that it would be finished in three years, but the final figuring of the mirror may require a longer time.

In one of the smaller domes in the administration building it is proposed to mount the 19-in. reflecting telescope recently constructed at the University of Toronto, by Professor R. K. Young, while, in the other small one, there will be three astronomical cameras on a single mounting. The chief parts of these cameras are already on hand, and the mounting will be made in the observatory workshop. In the central dome it is hoped to mount a 10-in. telescope of the refracting (or ordinary) type. This will be used for the observation of planets, comets, occultations, and double stars, and will also be available for public purposes.

Canadian Engineer Sept. 15.

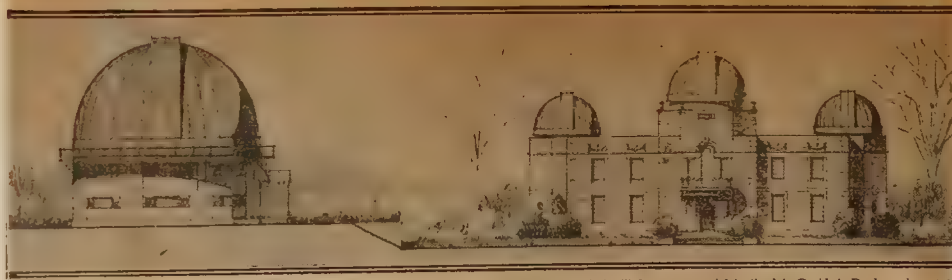
BIGGEST TELESCOPE

By Canadian Press

VICTORIA, Aug. 11. ... [illegible] ... enced in obtaining the mirrors.

Vancouver Sun. B.C. Aug. 11, 1932

Where Toronto Scientists Will Scan Heavens Through World's Second-Largest Telescope



Architects' drawing of the new Dunlap Observatory of the University of Toronto shows, at the left, the structure housing the great telescope and, at the right, the Administration building. The site is a 177-acre park near Richmond Hill, and the $500,000 project will form a memorial to the late David A. Dunlap, whose great interest was astronomy. The mirror of the great telescope will have a 74-inch aperture, and thus will be the second largest in the world.

Toronto Globe. August 16, 1932

DETAILS of the erection near Richmond Hill, north of Toronto, of the second largest telescope in the world, at an estimated cost of $500,000, were made public last night. Officials of the University of Toronto, to which Mrs. Jessie Dunlap is donating the David Dunlap observatory in memory of her husband, announced that construction would start at once on the two main buildings of the plant.

Sault Ste Marie Star. Ont. Aug. 16.

TORONTO PLANNING GREAT TELESCOPE

TORONTO, Aug. 16. Details of the ... near Richmond Hill, north of ... [illegible] ... the two main buildings of the plant.

Edmonton Bulletin. Alta. Aug. 16, 1932

Planning Telescope To Cost $500,000

Will Be Erected on Richmond Hill, Near Toronto

TORONTO, Aug. 16.—Details of the erection near Richmond Hill, north of here, of the second largest telescope in the world at an estimated cost of $500,000 were made public Monday night.

Officials of the University of Toronto, to which Mrs. Jessie Dunlap is donating the David Dunlap observatory in memory of her husband, announced construction would start at once on the two main buildings of the plant.

On a circular platform 800 feet above sea level a round building 61 feet in diameter will be built to house the huge telescope, nearly all parts of which are being made in England. Larger than the one in the Dominion government observatory, Victoria, B.C., the telescope will be of the reflecting type and will have mirror weighing 5,000 pounds.

The telescope building and an administration building to be erected at a cost of $125,000 will be located in the centre of a 177-acre plot which will be known as the David Dunlap park.

Edmonton Journal. Alta. Aug. 16, 1932

NEW OBSERVATORY NEAR TORONTO

To Have Second Largest Telescope in the World.

Toronto, Aug. 16.—Construction of a building which will house the second largest telescope in the world and an administration building which will contain laboratories, lecture rooms, libraries and a workshop, will begin almost immediately about one mile south of Richmond Hill. The total cost of the observatory, including land, buildings and apparatus is approximately $500,000.

The observatory will be a memorial to the late David A. Dunlap who was a keen student of astronomy and will be built through funds provided by his widow, Mrs. Jessie D. Dunlap, with whom is associated their son, Moffat Dunlap. Upon completion it will be presented to the University of Toronto, and will be conducted by the Department of Astronomy, of which Prof. C. A. Chant is the head. Mathers & Haldenby, architects, prepared the plans for the Administration Building and for the renovation of an old red brick farmhouse on the property which will be used as living quarters for students and those in charge of the apparatus.

800 Feet Above Sea Level.

The buildings will lie in the midst of a 177-acre plot on land 800 feet above sea level, and about one mile south of the Village of Richmond Hill and one-half mile east of the Yonge street highway. This large acreage will be developed by the Faculty of Forestry and will be known as the David Dunlap Park.

The main telescope is of the reflecting type. In place of a lens it will be equipped with a concave mirror to collect light rays from a star and bring them to focus. This mirror will have a clear aperture of seventy-four inches, and will be fashioned from a disc of glass twelve inches thick and weighing about two and one-half tons. The order for the telescope was placed two years ago, and its construction is well advanced, although it will not be completed until next summer.

Special machinery was built to fashion the huge bearings of the apparatus and to polish the glass.

Galt Reporter. Ont. Aug. 16, 1932

TELESCOPE TO COST $500,000

Will Be Erected Near Richmond Hill—Widow Donates Money

TORONTO, Aug. 16.—(CP)—Details of the erection near Richmond Hill, north of here, of the second largest telescope in the world, at an estimated cost of $500,000, were made public last night.

Officials of the University of Toronto, to which Mrs. Jessie Dunlap is donating the David Dunlap observatory, in memory of her husband, announced that construction would start at once on the two main buildings of the plant.

On a circular platform, 800 feet above sea level a round building 61 feet in diameter will be built to house the huge telescope, nearly all parts of which are being made in England. Larger than the one in the Dominion observatory, Victoria, B.C., the telescope will be of the reflecting type and will have a mirror weighing 5000 pounds.

The telescope building and an administration building, to be erected at a cost of $125,000, will be located in the centre of a 177-acre plot, which will be known as the David Dunlap Park.

Brantford Expositor. Ont. Aug. 16, 1932

HUGE TELESCOPE FOR OBSERVATORY

Mrs. Jessie Dunlap Makes Half Million Dollar Donation In Husband's Memory.

Toronto, Aug. 16.—Details of the erection near Richmond Hill, north of here, of the second largest telescope in the world at an estimated cost of $500,000, were made public last night.

Officials of the University of Toronto, to which Mrs. Jessie Dunlap is donating the David Dunlap observatory in memory of her husband, announced that construction would start at once on the two main buildings of the plant.

On a circular platform 800 feet above sea level, a round building 61 feet in diameter, will be built to house the huge telescope, nearly all parts of which are being made in England.

Brockville. Ont. Aug. 16, 1932 Recorder-Times

Details Announced Of Big Observatory At Richmond Hill

Second-Largest Telescope in World Will Be Housed in Building Being Constructed and Tested in England

WILL BE MEMORIAL TO DAVID A. DUNLAP

Construction of a building which will house the second largest telescope in the world, and an administration building which will contain laboratories, lecture rooms, libraries and a workshop, will begin almost immediately about one mile south of Richmond Hill. The total cost of the observatory, including land, buildings and apparatus, is approximately $500,000.

The observatory will be a memorial to the late David A. Dunlap, who was a keen student of astronomy, and will be built through funds provided by his widow, Mrs. Jessie D. Dunlap, with whom is associated their son, Moffat Dunlap. Upon completion it will be presented to the University of Toronto, and will be conducted by the Department of Astronomy, of which Prof. C. A. Chant is the head. Mathers & Haldenby architects, prepared the plans for the Administration Building and for the renovation of an old red brick farmhouse on the property, which will be used as living quarters for students and those in charge of the apparatus.

800 Feet Above Sea Level.

The buildings will lie in the midst of a 177-acre plot of land, 800 feet above sea level, and about one mile south of the Village of Richmond Hill and one-half mile east of the Yonge Street Highway. This large acreage will be developed by the Faculty of Forestry and will be known as the David Dunlap Park.

The main telescope is of the reflecting type. In place of a lens it will be equipped with a concave mirror to collect light rays from a star and bring them to focus. This mirror will have a clear aperture of seventy-four inches, and will be fashioned from a disc of glass twelve inches thick and weighing about two and one-half tons. The order for the telescope was placed two years ago and its construction is well advanced although it will not be completed until next summer. Special machinery was built to fashion the huge bearings of the apparatus and to polish the glass. The casting of the immense block of glass, the annealing and the grinding and polishing of its surface to a correctness of one-half millionth of an inch is a lengthy process but every effort is being made to have the apparatus in working order by December, 1933.

The structure which will contain the huge telescope will be a circular building, sixty-one feet in diameter, surmounted by a metal hemispherical dome, which will be revolved by an electric motor. The framework is of steel. The walls will be two feet thick and hollow, being sheathed on the inside and outside with galvanized iron in order that temperature changes will not affect the delicate mechanism of the telescope. The inner and outer surfaces of the dome, also two feet apart, will be covered with a special mixture of papier-mache and the outer surface will be covered by a layer of sheet copper for protection against the weather. The building is being constructed in England by the firm of Sir Howard Grubb, Parsons & Company, Newcastle-on-Tyne, which is also building the telescope. The structure will be shipped to Richmond Hill in about a year after it has been set up and tested in England. This summer, however, the cement foundation of the building will be laid and the immense pier which will carry the 50-ton telescope will be erected.

The Administration Building, constructed from Credit Valley limestone, with trimming of Queenston or Indiana stone, will be ninety-one feet long by forty-nine feet wide, with semi-octagonal projections on each end. On the roof will be a small dome at either end and a large dome at the centre. In one of the small domes will be mounted the 19-inch reflecting telescope recently constructed by Professor R. K. Young of the University of Toronto, while in the other small dome there will be three astronomical cameras on a single mounting. In the central dome a ten-inch telescope of the refracting type probably will be mounted. This is to be used for the observation of planets, comets, occulations and double stars, and will be available for public purposes. The building will be equipped with the most modern computing instruments, and the entrance hall and main staircase will be finished in marble.

RICHMOND HILL SITE OF BIG TELESCOPE

TORONTO, Aug. 16—Details of the erection near Richmond Hill, north of here, of the second largest telescope in the world at an estimated cost of $500,000, where made public last night.

Officials of the University of Toronto to which Mrs. Jessie Dunlap is donating the David Dunlap observatory in memory of her husband, announced that construction would start at once on the two main buildings of the plant.

On a circular platform 800 feet above sea level a round building 61 feet in diameter will be built to house the huge telescope, nearly all parts of which are being made in England.

Sun Times Owen Sound Ont. Aug. 16, 1932

WORK BEGINS SOON ON NEW OBSERVATORY

Mirror To Be 12 Inches Thick and Weighs $2\frac{1}{2}$ Tons

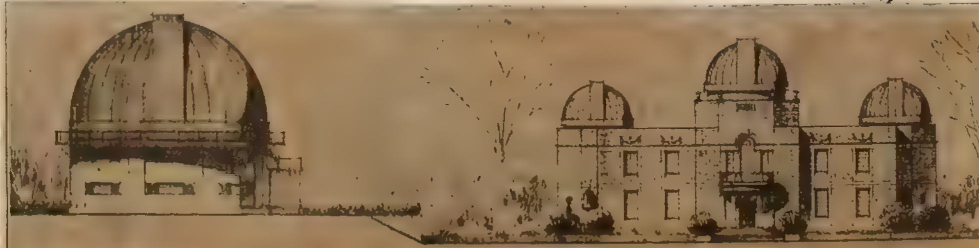
The construction of the $500,000 Dunlap observatory which will be presented to the University of Toronto is to begin within the next few days on a 177-acre plot of land about one mile south of Richmond Hill. The buildings will house the world's second largest telescope and laboratories, lecture rooms, libraries, and a workshop.

The observatory will be built through funds provided by Mrs. Jessie D. Dunlap, and her son Moffat Dunlap, in memory of her husband, David A. Dunlap, who was a keen student of astronomy. Upon completion it will be presented to the university and placed under the department of astronomy of which Prof. C. A. Chant is the head.

The land on which the buildings will be is 800 feet above sea level and half a mile east of Yonge St. highway. This acreage will be developed by the department of forestry, U. of T., and will be known as David Dunlap Park.

The main telescope is of the reflecting type, having in place of a lens a concave mirror to collect light rays from a star and bring them to focus. The mirror will be fashioned from a disc of glass 12 inches thick and will weigh two and a half tons.

The casting, annealing and grinding, and polishing of the immense block of glass which has to be exact to one-millionth of an inch is a lengthy process and it is not expected to be ready for shipment before December, 1933.



NEW DUNLAP OBSERVATORY AT RICHMOND HILL FOR UNIVERSITY ASTRONOMY DEPARTMENT

Architect's drawing of the new Dunlap Observatory, at LEFT the structure housing the new telescope, which will be the second largest in the world and at the right the $125,000 administration building. The site of this observatory is a 177 acre lot one mile south of Richmond Hill and one-half a mile east of the Yonge St. highway. The total layout which will cost $500,000, is a gift of the Dunlap estate, through Mrs. Jessie Dunlap and her son to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

Toronto Daily Star. Aug. 16. 1932

TORONTO GETS BIG TELESCOPE

C. D. Gibb of Newcastle-on-Tyne, in Charge of Dunlop Memorial, Here To-day

Seventy-four-inch Instrument Slightly Larger Than One at Saanich

Toronto will shortly boast an astrophysical telescope that will be slightly larger than the one established on Little Saanich Mountain, near here, it was learned with the arrival in the city to-day of C. D. Gibb, director of Sir Howard Grubb, Parsons & Company of Newcastle-on-Tyne, builders of the instrument.

Mr Gibbs, who is accompanied by F. J. Bell of Toronto, Canadian representative of the company, is staying at the Empress Hotel.

The Toronto University Observatory will be known as the Dunlop Memorial Observatory. The construction of this telescope has been under way for about a year. It will be built on a hill approximately 1,000 feet above sea level.

VISITED OBSERVATORY

Messrs Gibb and Bell this morning went out to Saanich to examine the 72-inch telescope which is in operation at the astrophysical observatory here. As compared with the 72-inch telescope here, the Toronto observatory will be equipped with a 74-inch instrument.

At the present time the local telescope is the second largest in the world, being exceeded in size by Mount Wilson, near Pasadena, Calif., which boasts a 100-inch telescope.

A 200-inch astrophysical telescope, it is understood, is being planned for southern California, but it is reported that trouble is being experienced in obtaining the mirrors.

Miss Kay Williams, organizing secretary of the European astronomical tour party now in the city, says the largest telescope in Great Britain is a 36-inch one at Greenwich Observatory. A 36-inch instrument has just been completed at Edinburgh to replace a 30-inch one there.

Victoria Times. B.C. Aug. 16, 1932

$500,000 Telescope Is Widow's Gift In Memory of Husband

TORONTO, Aug. 16.—(CP)—Details of the erection near Richmond Hill, north of here, of the second largest telescope in the world, at an estimated cost of $500,000, were made public here.

Officials of the University of Toronto, to which Mrs. Jessie Dunlap is donating the David Dunlap Observatory in memory of her husband, announced construction would start at once on the two main buildings of the plant.

On a circular platform 800 feet above sea level, a round building sixty-one feet in diameter will be built to house the huge telescope, nearly all parts of which are being made in England. Larger by two feet than the one in the Dominion Government Observatory, Victoria, B.C., the telescope will be of the reflecting type and will have mirrors weighing 5000 pounds.

The telescope building and an administration building, to be erected at a cost of $125,000, will be located in the centre of a 177-acre plot which will be known as the David Dunlap Park.

Vancouver Province. B.C. Aug. 16. 1932

TORONTO WILL HAVE GIGANTIC TELESCOPE

Mrs. Jessie Dunlap to Make $500,000 Gift

TORONTO, Aug. 16 — (C. P.) — Details of the erection near Richmond Hill, north of here, of the second largest telescope in the world, at an estimated cost of $500,000, were made public last night.

Officials of the University of Toronto to which Mrs. Jessie Dunlap is donating the David Dunlap Observatory in memory of her husband, announced construction would start at once on the two main buildings of the plant.

On a circular platform 800 feet above sea level, a round building 61 feet in diameter will be built to house the huge telescope, nearly all parts of which are being made in England. Larger than the one in the Dominion Government Observatory, Victoria, B.C., the telescope will be of the reflecting type and will have a mirror weighing 5,000 pounds.

The telescope building and an administration building to be erected at a cost of $125,000, will be located in the centre of a 177-acre plot which will be known as the David Dunlap Park.

Montreal Star. Que. Aug. 16.

Second Largest Telescope Will Be At Toronto

TORONTO, Aug. 16. — Details of the erection near Richmond Hill, north of here of the second largest telescope in the world, at an estimated cost of $500,000, were made public last night.

Officials of the University of Toronto to which Mrs. Dunlap is donating the David Dunlap observatory in memory of her husband, announced that construction would start at once on the two main buildings of the plant.

On a circular platform 800 feet above sea level, a round building 61 feet in diameter will be built to house the huge telescope, nearly all the parts of which are being made in England. Larger than the one in the Dominion government observatory, Victoria, B.C., the telescope will be of the reflecting type and will have mirrors weighing 5,000 pounds.

The telescope building and an administration building to be erected at a cost of $125,000, will be located in the center of a 177 acre plot which will be known as the David Dunlap Park.

Ft. William Times-Journal Ont. Aug. 16, 1932

WORK BEGINS AT ONCE

Second Largest Telescope in World Will Be in Toronto

Toronto, August 15 — Details of the erection near Richmond Hill, north of here, of the second largest telescope in the world, at an estimated cost of $500,000, were made public tonight.

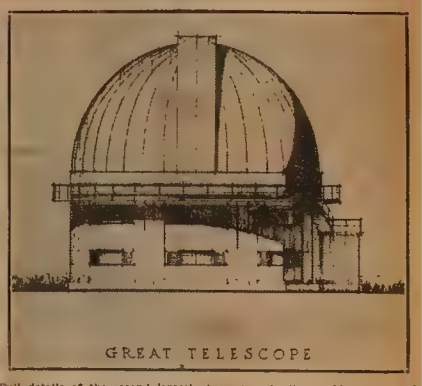
Officials of the University of Toronto to which Mrs Jessie Dunlap is donating the David Dunlap observatory in memory of her husband, announced that construction would start at once on the two main buildings of the plant.

On a circular platform 800 feet above sea level, a round building 61 feet in diameter will be built to house the huge telescope, nearly all parts of which are being made in England. Larger than the one in the Dominion Government Observatory, Victoria, B.C., the telescope will be of the reflecting type and will have mirror weighing 5,000 pounds.

The telescope building and an administration building to be erected at a cost of $125,000, will be located in the centre of a 177 acre plot which will be known as the David Dunlap Park.

Montreal Gazette. Que. Aug. 16, 1932

Dunlap Memorial Observatory and Administration Building



Full details of the second largest observatory in the world, erection of which will begin on property a mile south of Richmond Hill immediately, were released last night. It is being provided as a memorial to the late David A. Dunlap, by his widow, Mrs Jessie D Dunlap. The administration building, shown in the Upper sketch, will cost $125,000. Below is shown the observatory itself, work on the telescope and other parts of which has been proceeding in England for two years and may require another year yet. When completed, the memorial and 177-acre park in which it is situated will be turned over to the University of Toronto

Toronto Mail and Empire Aug. 16, 1932

A great new telescope to be erected at Richmond Hill, a few miles north of Toronto, will promote the study of astronomy in these parts and be a further worthy monument to the generosity of Mrs David A. Dunlap.

Toronto Globe. Aug. 17, 1932

TORONTO TO HAVE LARGE TELESCOPE

To Be Erected As Memorial To David A. Dunlap, By His Widow

TORONTO, Aug. 16. — Details were made public last night of the erection of the second largest telescope in the world at an estimated cost of $500,000, as a memorial to David A Dunlop by his widow.

Work on the administration building, one of the two chief buildings being erected as part of the David Dunlap Observatory, will start immediately, officials of the University of Toronto said. The administration building costs in the neighborhood of $125,000 while the greater part of the cost is involved in the erection of a circular building 61 feet in diameter to house the huge telescope, virtually all of which is now being constructed in England. The mirror alone weighs 5,000 pounds.

The two buildings will be located in the centre of a 177-acre plot of land a mile south of Richmond Hill and half a mile east of Yonge street in Markham township. The acreage, now farmland, will be made into a park to be known as the David Dunlap Park.

The round building will be on a circular platform 800 feet above sea level while the administration building will be on a level five feet below and in front of it will be an area three feet lower still.

Reflecting Type

The telescope, larger than the one in the Dominion Government observatory at Victoria, B. C., is of the reflecting type, that is, in place of a lens it will use a concave mirror to collect the rays of light from a star and bring them to a focus. This mirror will have a clear aperture of 74 inches, and will be fashioned from a disc of glass 76 inches in diameter and 12 inches thick.

The telescope was ordered more than two years ago from the firm of Sir Howard Grubb, Parsons & Company, Newcastle-on-Tyne, England, and the construction is well advanced. It was estimated that it would be finished in three years, but the final figuring of the mirror may require a longer time.

In one of the smaller domes in the administration building it is proposed to mount the 19 inch reflecting telescope recently constructed at the University of Toronto by Professor R. K. Young, while, in the other small one, there will be three astronomical cameras on a single mounting. The chief parts of these cameras are already on hand, and the mountings will be made in the observatory workshop. In the central dome it is hoped to mount a 10-odd inch type of the refracting (or lens) type. This will be used for observation of planets, comets, constellations, and double stars, and will also be available for public purposes.

Kitchener Record. Ont. Aug. 16. 1932

New Canadian Observatory to be Second Largest in the World

NEW DUNLAP OBSERVATORY AT RICHMOND HILL, ONTARIO, FOR UNIVERSITY OF TORONTO ASTRONOMY DEPARTMENT

Architect's drawing of the new Dunlap Observatory to be built at Richmond Hill, Ontario, for the University of Toronto Astronomy Department. At RIGHT the will cost $500,000 is a gift of the the late David A Dunlop, who was ture housing a new telescope, which will be the second largest in the 177 acres. The total layout, which site of Toronto to commemorate the stars.

Welland-Pt. Colborne Eve. Tribune. Ont. Aug. 17, 1932

Observatory Erection To Begin Immediately

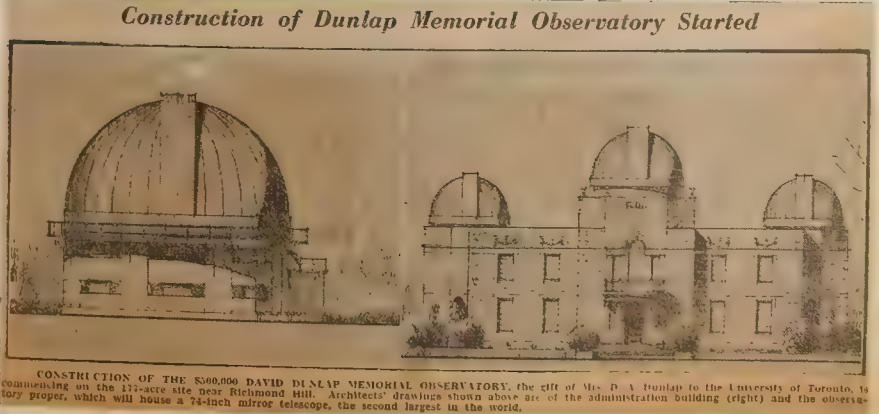
Work on the administration building of the David Dunlop Observatory a mile south of Richmond Hill is to begin immediately, it was announced last night. The observatory, costing $500,000 and housing the second largest telescope in the world, is being erected as a memorial to David A Dunlap by his widow.

The administration building, one of the two chief structures, costs about $125,000, but the greater part of the expense is involved in the erection of a circular building 61 feet in diameter, 800 feet above sea level, and the 74-inch mirror telescope that is to be installed there. The two buildings will be in the centre of a 177-acre plot half a mile east of Yonge street in Markham Township. The area is to be developed into a park to be known as the David Dunlap Park.

The great telescope was ordered about two years ago from England and is expected to be completed in another years time. A 19-inch reflecting telescope, constructed by Professor R K Young at the University of Toronto will be housed in one of the smaller domes in the administration building, while in the other small dome there will be three astronomical cameras.

Toronto Telegram. August. 16, 1932

Construction of Dunlap Memorial Observatory Started



CONSTRUCTION OF THE $500,000 DAVID DUNLAP MEMORIAL OBSERVATORY, the gift of Mrs. D. A. Dunlap to the University of Toronto, is commencing on the 177-acre site near Richmond Hill. Architects' drawings shown above are of the administration building (right) and the observatory proper, which will house a 74-inch mirror telescope, the second largest in the world.

OBSERVATORY TO BE ERECTED NEAR RICHMOND HILL

The world's second largest telescope will be erected in the new Dunlap Observatory of the University of Toronto, which will be located in Markham township just south of Richmond Hill. The above layout shows architect's drawings, at the left the structure to house the great telescope and at the right the administration building.

Construction of a building which will house the second largest telescope in the world, and an administration building which will contain laboratories, lecture rooms, libraries and a workshop, will begin almost immediately. The total cost of the observatory, including land, buildings and apparatus, is approximately $500,000.

The observatory will be a memorial to the late David A. Dunlap, who was a keen student of astronomy, and will be built through fund provided by his widow, Mrs. Jessie D. Dunlap, with whom is associated their son, Moffat Dunlap. Upon completion it will be presented to the University of Toronto, and will be conducted by the Department of Astronomy, of which Prof. C. A. Chant is the head. Mathews & Haldenby, architects, prepared the plans for the Administration Building and for the renovation of an old red brick farm-house on the property which will be used as living quarters for students and those in charge of the apparatus.

800 Feet Above Sea Level.

The buildings will lie in the midst of a 177-acre plot of land, 800 feet above sea level, and about one mile south of the Village of Richmond Hill and one-half mile east of the Yonge Street Highway. This large acreage will be developed by the Faculty of Forestry and will be known as the David Dunlap Park.

The main telescope is of the reflecting type. In place of a lens it will be equipped with a concave mirror to collect light rays from a star and bring them to focus. This mirror will have a clear aperture of seventy-four inches and will be fashioned from a disc of glass twelve inches thick and weighing about two and one-half tons. The order for the telescope was placed two years ago, and its construction is well advanced, although it will not be completed until next summer. Special machinery was built to fashion the huge bearings of the apparatus and to polish the glass. The casting of the immense block of glass, the annealing and the grinding and polishing of its surface to a correctness of one-half millionth of an inch, is a lengthy process, but every effort is being made to have the apparatus in working order by December, 1933.

The structure which will contain the huge telescope will be a circular building, sixty-one feet in diameter, surmounted by a metal hemispherical dome, which will be revolved by an electric motor. The framework is of steel. The walls will be two feet thick, and hollow, being sheathed on the inside and outside with galvanized iron in order that temperature changes will not affect the delicate mechanism of the telescope. The inner and outer surfaces of the dome, also two feet apart, will be covered with a special mixture of papier-mache and the outer surface will be covered by a layer of sheet copper for protection against the weather. The building is being constructed in England by the firm of Sir Howard Grubb, Parsons & Company, Newcastle-on-Tyne, which is also building the telescope. The structure will be shipped to Richmond Hill in about a year after it has been set up and tested in England. This summer, however, the cement foundation of the building will be laid and the immense pier which will carry the 50-ton telescope will be erected.

The Administration Building, constructed from Credit Valley limestone, with trimmings of Queenston or Indiana stone, will be ninety-one feet long by forty-nine feet wide, with semi-octagonal projections at each end. On the roof will be a small dome at either end and a large dome at the centre. In one of the small domes will be mounted the 19-inch reflecting telescope recently constructed by Professor R. K. Young of the University of Toronto, while in the other small dome there will be three astronomical cameras on a single mounting. In the central dome a ten-inch telescope of the refracting type probably will be mounted. This is to be used for the observation of planets, comets, occulations and double stars, and will be available for public purposes. The building will be equipped with the most modern computing instruments, and the entrance hall and main staircase will be finished in marble.

Richmond Hill Liberal. Ont. Aug. 18, 1932

New Landmark To Be Erected on Yonge Street Highway

DETAILS ANNOUNCED OF BIG OBSERVATORY AT RICHMOND HILL

Second-Largest Telescope in World Will Be Housed in Building Being Constructed and Tested in England

Construction of a building which will house the second largest telescope in the world, and an administration building which will contain laboratories, lecture rooms, libraries and a workshop, will begin almost immediately about one mile south of Richmond Hill. The total cost of the observatory, including land, buildings and apparatus, is approximately $500,000.

The observatory will be a memorial to the late David A. Dunlap, who was a keen student of astronomy, and will be built through funds provided by his widow, Mrs.. Jessie D. Dunlap, with whom is associated their son, Moffat Dunlap. Upon completion it will be presented to the University of Toronto and will be conducted by the Department of Astronomy, of which Prof. C. A. Chant is the head. Mathews & Haldenby, architects, prepared the plans for the administration Building and for the renovation of an old red brick farmhouse on the property, which will be used as living quarters for students and those in charge of the apparatus.

The buildings will lie in the midst of a 177-acre plot of land 800 feet above sea level, and about one mile south of the village of Richmond Hill and one half mile east of the Yonge street Highway. This large acreage will be developed by the Faculty of Forestry and will be known as the David Dunlap Park.

The main telescope is of the reflecting type. In place of a lens it will be equipped with a concave mirror to collect light rays from a star and bring them to focus. This mirror will have a clear aperture of seventy-four inches, and will be fashioned from a disc of glass twelve inches thick and weighing about two and one-half

The order for the telescope was placed two years ago, and its construction is well advanced, although it will not be completed until next summer. Special machinery was built to fashion the huge bear-

purposes. The building will be equipped with the most modern computing instruments, and the entrance hall and main staircase will be finished in marble.

Penetanguishene Herald. Ont. Aug. 18, 1932

The David Dunlap Observatory at Toronto is to house the second largest telescope in the world and is to be in the centre of the park of that name. The telescope will be considerably larger than the one in the Dominion Government Observatory at Victoria, B.C., and when it is in operation Canada will be well-equipped to observe the wonders of the heavens. Thanks are due to Mrs. Jessie Dunlap, who has provided the funds for the institution, which is in memory of her late husband.

Montreal Gazette Que. Aug. 18, 1932

NEW CANADIAN OBSERVATORY TO BE SECOND LARGEST IN THE WORLD

NEW DUNLAP OBSERVATORY AT RICHMOND HILL, ONTARIO, FOR UNIVERSITY OF TORONTO ASTRONOMY DEPARTMENT

Architect's drawing of the new which will be the second largest in the world, and at the right the 177 acres. The total layout, which Dunlap Observatory; at left the structure housing a new telescope, $125,000 administration building, with cost $500,000 is a gift of the Dunlap estate, through Mrs. Jessie Dunlap and her son, to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

Owen Sound Sun Times. Ont. Aug. 17, 1932

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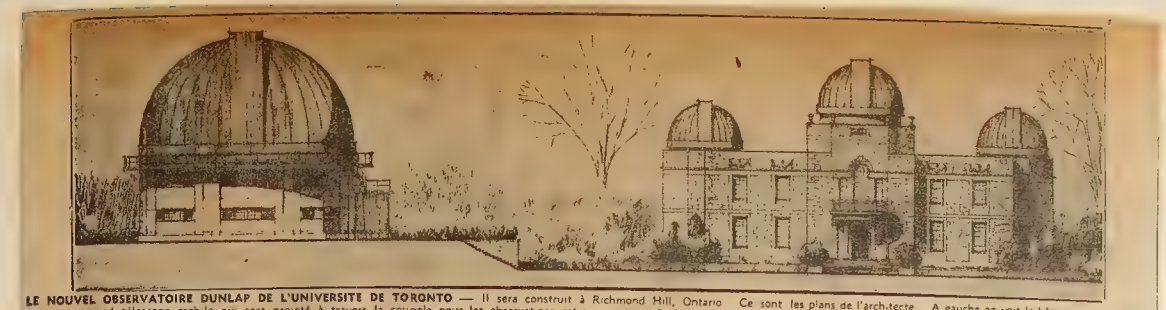
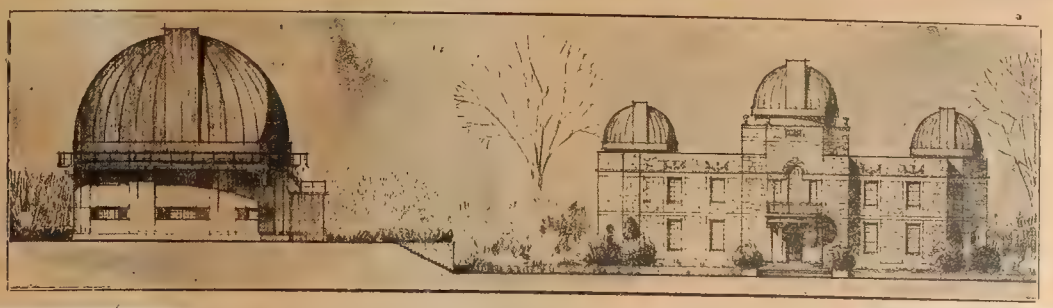
Peterborough Examiner. Ont. Aug. 18, 1932



LE NOUVEL OBSERVATOIRE DUNLAP DE L'UNIVERSITE DE TORONTO — Il sera construit à Richmond Hill, Ontario. Ce sont les plans de l'architecte. A gauche on voit la bâtisse qui abritera le grand télescope mobile qui sera projeté à travers la coupole pour les observations astronomiques. A droite, on aperçoit l'édifice des bureaux d'administration. Cet observatoire a été donné à l'Université par Mme Jessie Dunlap et son fils, en mémoire de feu David Dunlap, astronome réputé.

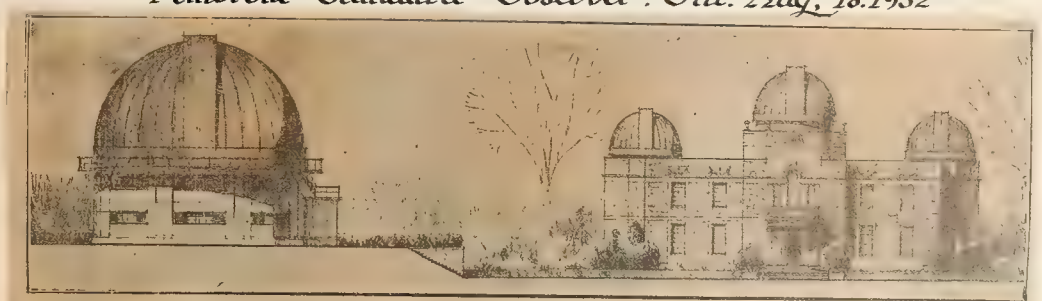
Montreal Le Devoir. Que. Aug. 18, 1932

New Canadian Observatory to Be Second Largest in the World



Architect's drawing of the new Dunlap Observatory; at left, the structure housing a new telescope, which will be the second largest in the world, and at the right, the $125,000 administration building. The site of this observatory covers 177 acres. The total layout, which will cost $550,000 is a gift of the Dunlap estate, through Mrs. Jessie Dunlap and her son, to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

Pembroke Standard-Observer. Ont. Aug. 18. 1932



Architect's drawing of the new Dunlap Observatory, at left, building. The site of this observatory covers 177 acres. The of Toronto, to commemorate the late David A. Dunlap, who wa the structure housing a new telescope, which will be the second total layout, which will cost $500,000, is a gift of the Dunlap greatly interested in the science of the stars largest in the world, and at the right the $125,000 administration estate, through Mrs. Jessie Dunlap and her son, to the University

Kingston Whig-Standard. Ont. Aug. 17, 1932

NEW CANADIAN OBSERVATORY TO BE SECOND LARGEST IN THE WORLD

Architect's drawing of the new Dunlap Observatory; at LEFT, the structure housing a new telescope, which will be the second largest in the world, and at the RIGHT the $125,000 administration building. The site of this observatory covers 177 acres. The total layout, which will cost $500,000, is a gift of the Dunlap estate, through Mrs. Jessie Dunlap and her son, to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

Woodstock Sentinel-Review. Ont. Aug. 17, 1932

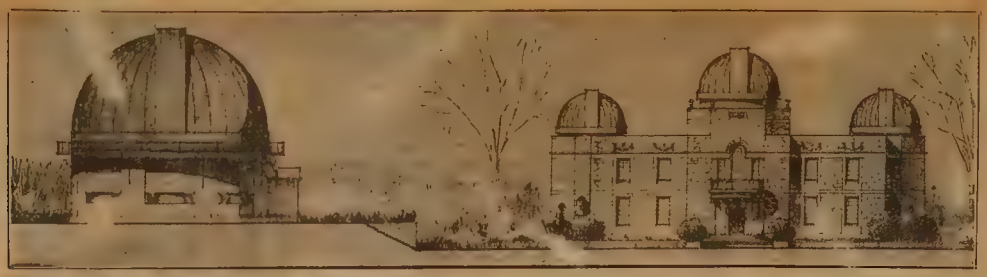
NEW CANADIAN OBSERVATORY AT RICHMOND HILL, ONTARIO, TO BE SECOND LARGEST IN WORLD.

St. Thomas Times-Journal.

Architect's drawing of the new Dunlap Observatory. At left, the structure housing a new telescope, which will be the second largest in the world, and at the right the $125,000 administration building. The site of this observatory covers 177 acres. The total layout, which will cost $500,000, is a gift of the Dunlap estate through Mrs. Jessie Dunlap and her son, to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

Ont. August 18. 1932

New Canadian Observatory to be Second Largest in the World



NEW DUNLAP OBSERVATORY AT RICHMOND HILL, ONTARIO, FOR UNIVERSITY OF TORONTO ASTRONOMY DEPARTMENT

Architect's drawing of the new Dunlap Observatory, at left, the structure housing a new telescope, which will be the second largest in the world, and at the right the $12 000 administration building. The site of this observatory covers 177 acres. The total layout, which will cost $500,000, is a gift of the Dunlap estate, through Mrs. Jessie Dunlap and her son, to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

St. Catharines Standard. Ont. Aug. 19.

NEW CANADIAN OBSERVATORY TO BE SECOND LARGEST IN THE WORLD

Architect's drawing of the new Dunlap Observatory; at left, the structure housing a new telescope, which will be the second largest in the world, and at the right the $125,000 administration building. The site of this observatory covers 177 acres. The total layout, which will cost $500,000, is a gift of the Dunlap estate, through Mrs. Jessie Dunlap and her son, to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

Galt Reporter. Ont. Aug. 19.

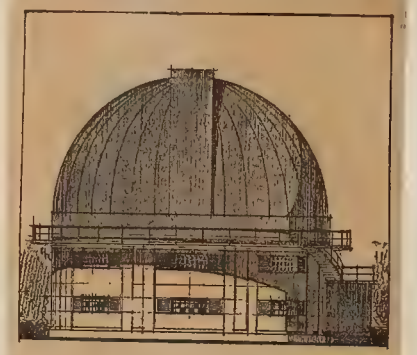
Work To Start On Giant Observatory

GREAT TELESCOPE

The second largest observatory in the world will be erected near Richmond Hill, Ontario, as a memorial to the late David A. Dunlap by his widow Mrs. Jessie D. Dunlap. The observatory will house a huge telescope the mirror of which alone weighs 5,000 pounds. In addition there will be a computing building which will contain other telescopes and there will be cameras [illegible]. The estimated cost will be in the neighborhood of $500,000. Above is a drawing of the great observatory by the architects Mathers and Haldenby.

Kitchener Record. Ont. Aug. 19

Un immense observatoire



Le deuxième observatoire en importance au monde est sur le point d'être commencé à Richmond Hill, Ontario. Il sera élevé à la mémoire de feu David A. Dunlap par son épouse Mme Jessie D. Dunlap. Le coût de la construction sera d'environ $500,000. L'observatoire comprendra un immense telescope dont le miroir pèsera à lui seul 5,000 livres. Dans les bureaux de l'administration il y aura deux télescopes plus petits et deux cameras astronomiques. Voici les plans de la bâtisse tels que préparés par les architectes Mathers et Haldenby.

Three Rivers Le Nouvelliste. Que. August 19

NEW DUNLAP OBSERVATORY AT RICHMOND HILL, ONTARIO, FOR UNIVERSITY OF TORONTO ASTRONOMY DEPARTMENT

Architect's drawing of the new Dunlap Observatory, $12,000 administration building. The site of this observa- Dunlap and her son, to the University of Toronto, to com- at left, the structure housing a new telescope, which will cost memorate the late David A. Dunlap, who was greatly be the second largest in the world, and at the right the $500,000, is a gift of the Dunlap estate, through Mrs. Jessie interested in the science of the stars.

Sudbury Star. Ont. Aug. 20.

LARGE TELESCOPE COMING TO CANADA

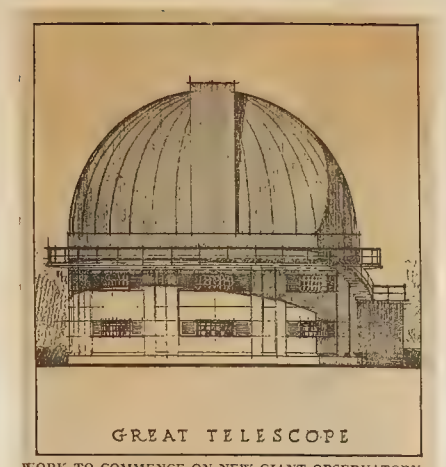
Will Be Housed in Memorial Observatory Near Toronto.

Toronto, Aug. 20—There will be completed next year at Newcastle-on-Tyne, England, the second largest telescope in the world. It will be shipped to Canada and erected in a new observatory located on high ground a few miles north of Toronto. The observatory is being built as a memorial to the late David A. Dunlap, who in his lifetime was a keen student of astronomy, funds being provided by his widow and son. Upon completion, it will be presented to the University of Toronto and will be conducted by the Department of Astronomy of the institution. The buildings comprising the observatory will stand in the midst of a 177-acre plot of land, 800 feet above sea level, and the property will be beautified by the Faculty of Forestry of the University and will be known as the David Dunlap Park.

The main telescope is of the reflecting type. In place of a lens it will be equipped with a concave mirror to collect light rays from a star and bring them to focus. This mirror will have a clear aperture of seventy-four inches, and will be fashioned from a disc of glass twelve inches thick and weighing about two and one-half tons. The order for the telescope was placed two years ago, and it's construction is well advanced, although it will not be completed until next summer. Special machinery was built to fashion the huge bearings of the apparatus and to polish the glass. The casting of the immense block of glass, the annealing and grinding and polishing of its surface to a correctness of one-half millionth of an inch, is a lengthy process, but every effort is being made to have the apparatus in working order by December, 1933.

The structure which will contain the huge telescope will be a circular building, sixty-one feet in diameter, surmounted by a metal hemispherical dome, which will be revolved by an electric motor. The framework is of steel. The walls will be two feet thick, and hollow, being sheathed on the inside and outside with galvanized iron in order that temperature changes will not affect the delicate mechanism of the telescope. The inner and outer surfaces of the dome, also two feet apart, will be covered with a special mixture of papier-mache and the outer surface will be covered by a layer of sheet copper for protection against the weather.

Fredericton Gleaner. N.B. Aug. 22.



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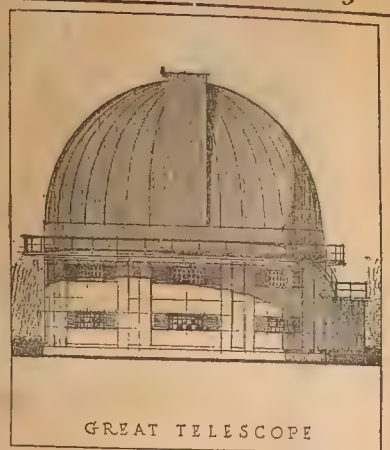
Hamilton Spectator. Ont. Aug. 22

New Giant Observatory



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Fredericton Gleaner. N.B. Aug. 22.

Big Observatory Planned

TORONTO, Aug. 20.—Approximately $500,000 will be spent on the construction of a new observatory near Richmond Hill, north of Toronto. The station will be known as the David Dunlap Observatory and is being donated to the University of Toronto by Mrs. Jessie Dunlap. It will contain the second largest telescope in the world, larger by two feet than the one in the Dominion Observatory in Victoria. Telescope building and administration building will cost approximately $125,000.

Vancouver Journal of Commerce. B.C. Aug. 22.

One more public benefaction attributable to the mining industry of Northern Ontario is the telescope to be erected at the David Dunlap Observatory at Toronto. The telescope will be the second largest in the world, considerably larger than the one in the Dominion Government Observatory at Victoria, B.C., and when it is in operation Canada will be well equipped to observe the wonders of the heavens. Mrs. Jessie Dunlap is providing the funds for the institution, which is in memory of her late husband, who was interested, with the Timmins brothers syndicate, in the LaRose and Hollinger mines.

Sudbury Star. Ont. Aug. 20.

NEW CANADIAN OBSERVATORY TO BE SECOND LARGEST IN THE WORLD

Architect's drawing of the new Dunlap Observatory; at LEFT, the structure housing a new telescope, which will be the second largest in the world, and at the RIGHT the $125,000 administration building. The site of this observatory covers 177 acres. The total layout, which will cost $500,000, is a gift of the Dunlap estate, through Mrs. Jessie Dunlap and her son, to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

Glace Bay Gazette. C.B. Aug. 20.

Observatory to Be Second Largest in World

ARCHITECT'S drawing of the new Dunlap Observatory; at LEFT, the structure housing a new telescope, which will be the second largest in the world, and at the RIGHT the $125,000 administration building. The site of this observatory covers 177 acres. The total layout, which will cost $500,000, is a gift of the Dunlap estate, through Mrs. Jessie Dunlap and her son, to the University of Toronto, to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

St. John Telegraph-Journal. N.B. Aug. 20.

HALF MILLION OBSERVATORY IS PLANNED

TORONTO, Aug 18 Details of the erection near Richmond Hill, north of here, of the second largest telescope in the world, at an estimated cost of $500,000, are made publit here.

Officials of the University of Toronto, to which Mrs Jessie Dunlap is donating the David Dunlap Observatory in memory of her husband, announced construction would start at once on the two main buildings of the plant

On a circular platform 800 feet above sea level a round building 61 feet in diameter will be built to house the huge telescope, nearly all parts of which are being made in England Larger than the one in the Dominion Government Observatory, Victoria, B. C., the telescope will be of the reflecting type and will have mirrors weighing 5000 pounds

The telescope building and an administration building, to be erected at a cost of $125,000, will be located in the centre of a 177-acre plot which will be known as the David Dunlap Park.

New Westminster British Columbian B.C. Aug. 23

New Canadian Observatory to Be Second Largest in the World

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Edmonton Journal Alta. Aug. 23

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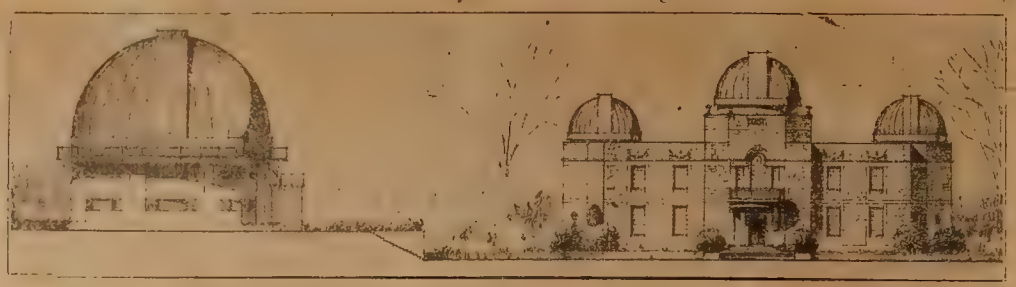

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New Glasgow Chronicle N.S. Aug. 23

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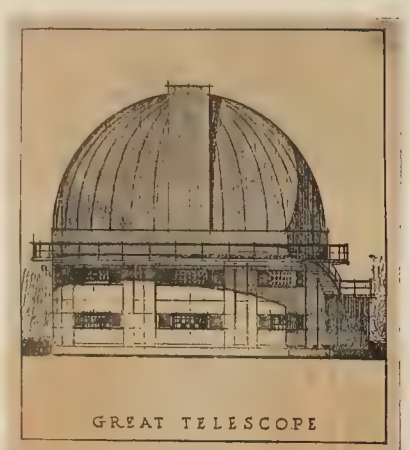
Rapid City Reporter. Man. Aug. 24.



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Niagara Falls Review Ont. Aug. 24.

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Canora Courier. Sask. Aug. 25

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Castor Advance Alta Aug. 23

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Blairmore Enterprise Alta. Aug. 25

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Orillia News-Letter. Ont. Aug. 24

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Eatonia Enterprise. Sask Aug. 25

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Eston Press Sask Aug. 25.

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Indian Head News. Sask. Aug. 25.

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Kinistino Representative Sask. Aug. 30

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La Fleche Press Sask Aug. 25

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Luseland Dispatch Sask. Aug. 25

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Rouleau Enterprise Sask. Aug. 25.

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Shaunavon Standard Sask. Aug. 25

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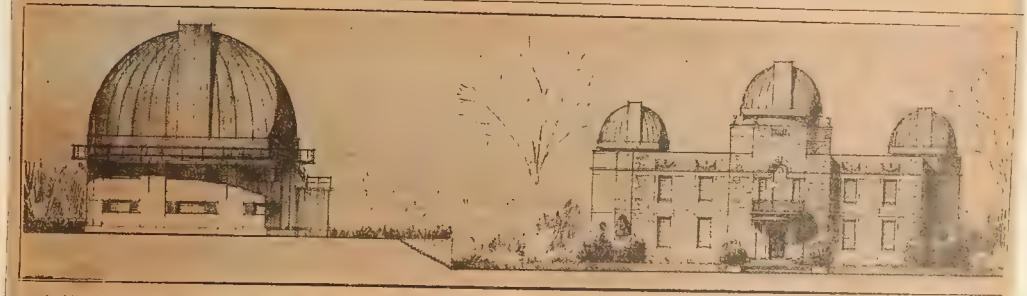

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Calgary Herald. Alta. Aug. 25

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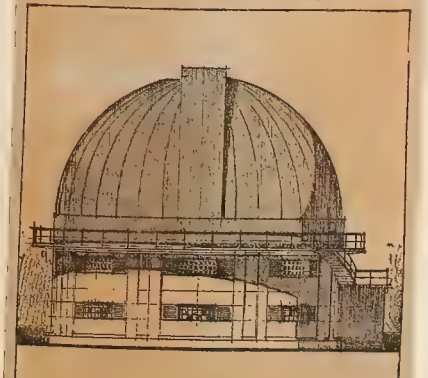
Alemeda Dispatch Sask. Aug. 26

NEW GIANT OBSERVATORY



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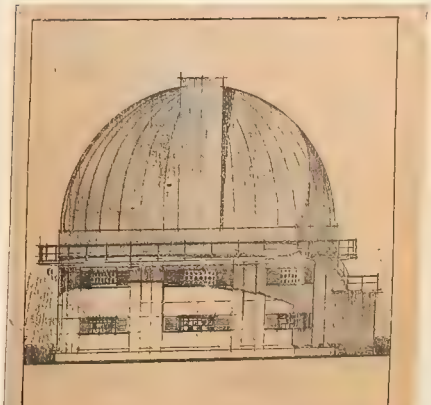
Calgary Albertan. Alta. Aug. 26



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Medicine Hat News. Alta. Aug. 20

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Moosomin World-Spectator. Sask. Aug. 31

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Elrose Review Sask. Sept. 1

Toronto Will Have Gigantic Telescope

MRS. JESSIE DUNLAP TO MAKE $500,000 Gift

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The telescope building and an administration building to be erected at a cost of $125,000, will be located in the centre of a 177-acre plot which will be known as the David Dunlap Park.

St. John's Telegram NFLD. Sept. 1

New Canadian Observatory To Be Second Largest in the World

Artist's sketch of the new Dunlap observatory showing at left the structure to house a new telescope, which will be the second largest in the world. At the right is shown the $125,000 administration building. The site of the observatory covers 177 acres. The total layout which will cost $500,000 is a gift of the Dunlap estate, through Mrs. Jessie Dunlap, and has been given to the University of Toronto to commemorate the late David A. Dunlap, who was greatly interested in the science of the stars.

Regina Leader-Post. Sask. Sept. 2

Build Huge Telescope

Second Largest Telescope In the World To Be Erected Near Toronto

Details of the erection near Richmond Hill, north of Toronto, of the second largest telescope in the world, at an estimated cost of $500,000 has been made public.

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On a circular platform 800 feet above sea level, a round building 61 feet in diameter will be built to house the huge telescope, nearly all parts of which are being made in England. Larger than the one in the Dominion Government observatory, Victoria, B.C., the telescope will be on the reflecting type and will have mirrors weighing 5,000 pounds.

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Saskatchewan Valley News. Rosthern, Sask. Sept. 7

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The Viking News Alta. Sept. 7

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The telescope building and an administration building to be erected at a cost of $125,000, will be located in the centre of a 177-acre plot, which will be known as the David Dunlap Park.

Pincher Creek Echo Sept. 8

RICHMOND HILL

Will Lay Cornerstone Observatory Sept. 10

Richmond Hill, Aug., 30.— Announcement that the corner stone of the administration building of the Dunlap Observatory at Richmond Hill will be laid on Saturday, Sept. 10, was made by Dr. H. J. Cody, president of the University of Toronto. Details of the ceremony will be announced later.

Toronto Telegram Aug. 30.

LAY STONE SEPT. 10

The president of the University of Toronto, Dr. H. J. Cody, announces that the corner-stone of the administration building of the Dunlap Observatory at Richmond Hill will be laid on Saturday afternoon, Sept. 10th, at 3 o'clock by Moffat Dunlap. Details will be announced later.

Toronto Daily Star Aug. 30

Lay Corner-stone Saturday of Dunlap Observatory

The president of the University of Toronto, Dr. H. J. Cody, announces that the corner-stone of the Administration Building of the Dunlap Observatory at Richmond Hill will be laid on Saturday afternoon, Sept. 10, at three o'clock by Moffat Dunlap. Details of the ceremony will be announced later.

Toronto Mail and Empire. Ont. Aug. 30

The huge reflecting telescope now under construction for the David Dunlap Observatory, University of Toronto, will be the second largest in the world.

St. John Times-Globe. N.B. Aug. 31

Announcement that the corner stone of the administration building of the Dunlap Observatory at Richmond Hill will be laid on Saturday, Sept. 10, was made by Dr. H. J. Cody, president of the University of Toronto. The cornerstone will be laid by Moffat Dunlap, who with his mother, Mrs. D. A. Dunlap, gave the funds for the building and equipment.

Tottenham Sentinel Ont. Sept. 1, 1932

The huge reflecting telescope now under construction for the David Dunlap Observatory, University of Toronto, will be the second largest in the world.

Montreal Gazette Que. Sept. 2, 1932

The mirror, for the huge reflecting telescope now being built for the David Dunlap Observatory, University of Toronto, will weigh 5,000 pounds.

Owen Sound Sun Times. Ont. Sept. 3, 1932

The mirror, for the huge reflecting telescope now being built for the David Dunlap Observatory, University of Toronto, will weigh 5,000 pounds.

Brandon Sun. Man. Sept. 5, 1932

Markham Twp., Ont

The following contracts have been awarded in connection with the erection of concrete, steel and stone administration building at David Dunlap observatory: elec., Standard Electric Contracting and Engineering Co., 105 Victoria St., Toronto; struct. steel, Dominion Bridge Co. Ltd., 1139 Shaw St., Toronto; reinf. steel, Truscon Steel Co. of Canada Ltd., Federal Bldg., Toronto; cut stone, Nicholson and Curtis, Leaside; light proof window shade, Higgin Mfg. Co., 33 McCaul St., Toronto; gravel, J. E. Montgomery, 95 Butterwood Ave., Mount Dennis. Owner, University of Toronto, archts., Mathers and Haldenby, 96 Bloor St. W., Toronto; gen. contr., Sullivan and Fried Ltd., 81 Victoria St., Toronto

Contract Record and Engineering Review Sept. 7

Will Lay Corner Stone.

Corner stone of the Administration building of the Dunlap observatory on Richmond Hill will be laid on Saturday at 3 p.m. by Moffat Dunlap. Dr. Cody, as president of the University of Toronto, will preside: Prof. C. A. Chant will describe the proposed building; Rev. Dr. Richard Roberts will offer prayer, and addresses will be given by Sir Wm. Mulock, Premier Henry and Hon. G. Howard Ferguson.

Toronto Telegram Sept. 7, 1932

The mirror, for the huge reflecting telescope now being built for the David Dunlap Observatory, University of Toronto, will weigh 5,000 pounds.

St. Catharines Standard Ont. Sept. 8, 1932

President of University to Open New Observatory

Under the direction of Rev. Canon H. J. Cody, president of the University of Toronto, the cornerstone of the new Dunlap Observatory, a gift to Toronto by Mrs. D. A. Dunlap, will be laid to-morrow afternoon at 3 o'clock. Moffat Dunlap will lay the stone after presentation of the trowel by Canon Cody. Before the laying of the stone, Prof. C. A. Chant will describe the proposed building and its purpose. Following the ceremony, addresses will be delivered by Sir William Mulock, Premier Henry and Hon. G. Howard Ferguson. The site of the observatory is south of Richmond Hill on the east side of Yonge Street.

Toronto Mail and Empire. Ont. Sept. 9

EDUCATIONAL and parliamentary dignitaries will gather at Richmond Hill, Ont., tomorrow at the ceremonies attending the laying of the cornerstone of the administration building of the David Dunlap Observatory of the University of Toronto. Canon H. J. Cody, president of the university, will be in charge of the ceremonies.

Sault Ste. Marie Star Oct. Sept. 9, 1932

TO LAY CORNERSTONE

(Canadian Press Despatch)

RICHMOND HILL, Ont., Sept. 9— Educational and parliamentary dignitaries will gather here tomorrow at the ceremonies attending the laying of the cornerstone of the administration building of the David Dunlap Observatory of the University of Toronto, Canon H. J. Cody, president of the University, will be in charge of the ceremonies.

Owen Sound Sun Times. Ont. Sept. 10, 1932

LAY CORNERSTONE OF OBSERVATORY

Provincial Officials Pay Tribute To Mrs. Dunlap For Princely Benefaction

TORONTO, Sept. 12.—The foundation stone of the Dunlap Observatory at Richmond Hill was laid by Moffat Dunlap on Saturday afternoon in memory of his father D. A. Dunlap and the deed of 177 acres surrounding it was handed to the University of Toronto by the donor, Mrs. Dunlap. In the presence of the premier of the province, the high commissioner to Great Britain and distinguished astronomers, professors and business men the ceremonies took place.

"This is a red letter day in the history of the university," said Dr. J. H. Cody, who presided at the ceremony, and declared that although the University of Toronto was a provincial institution, its benefactors had been numerous. He pointed out that all the investments of the university were gilt-edged, the sums being invested in Dominion, provincial or high-class municipal securities, and inferred that in a time of wavering stocks and money markets, the university stood sound and secure financially. No money was invested in mortgages, none in industrial stocks.

Expressing the gratitude of the university to Mrs. Dunlap for her princely benefaction, he commented that her husband the late David Dunlap, had used every effort to popularize interest in astronomy. The situation of the new observatory was ideal, 800 feet above the sea.

Interested In Idea

Professor A. C. Chant told of Mr. Dunlap's interest in the project. Following a lecture which he had given on astronomy and in which he had stated the need for a great observatory, Mr. Dunlap had come to him to bespeak his interest in the idea.

Hon. G. Howard Ferguson, Canadian High Commissioner, commented: "I am greatly impressed with the magnificence and extent of this gift through which Mrs. Dunlap is erecting a memorial to her husband. It must be a proud moment for her to see her son laying the cornerstone."

Announcement was made that England's Astronomer Royal, Sir Frank Dyson, as well as Eddington and Jeans and others in the galaxy of astronomers, were expected to be present at the opening of the new observatory.

The gratitude of the province was voiced by Premier Henry and a word of praise by Chancellor Sir William Mulock. Dr. D. Bruce Macdonald received the gift from the hands of Mrs. Dunlap on behalf of the university. Later Mrs. Dunlap entertained the guests at tea.

Kitchener-Record. Ont. Sept. 12

Observatory Stone Is Laid

DUNLAP MEMORIAL

Ferguson, Henry, Cody Are Heard at Ceremony

TORONTO, Sept. 12 In the presence of the premier of the province, the high commissioner to Great Britain, and distinguished astronomers, professors and business men, the foundation stone of the Dunlap Observatory at Richmond Hill was laid by Moffatt Dunlap on Saturday afternoon as memory of his father D A Dunlap and the deed of 177 acres surrounding it was handed over to the University of Toronto by Mrs. Dunlap, the donor.

"This is a red letter day in the history of the university" said Dr J H Cody who presided at the ceremony, and declared that although the University of Toronto was a provincial institution its benefactors had been numerous

Expressing the gratitude of the university to Mrs. Dunlap for her princely benefaction, he commented that her husband, the late David Dunlap, had used every effort to popularize interest in astronomy

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Border Cities Star Windsor, Ont. Sept. 12, 1932

Toronto Observatory

From Canadian Development News

An observatory that will house the second largest telescope in the world is to be constructed near Richmond Hill, Toronto district, and work on the administration building is to commence immediately, according to officials of the University of Toronto. The huge telescope, now under construction in England, is expected to be finished within the next year, and the observatory, when fully completed, will be turned over to the University of Toronto. The observatory, which is in the nature of a memorial to the late David A. Dunlap, will cost $500,000 to complete and equip, and will be known as the "David Dunlap Observatory."

Funds for the project are being provided by Mrs. Jessie D. Dunlap, widow of the late David A. Dunlap, with whom is associated their son, Moffat Dunlap. The completed observatory will be presented to the University of Toronto, and will be conducted by the department of astronomy, of which Professor C. A. Chant is head.

The two main buildings of the observatory will be erected in the centre of a 177-acre plot, 800 feet above sea level and about one mile south of the village of Richmond Hill. The whole area will be developed by the faculty of forestry, University of Toronto, and will be known as the "David Dunlap Park."

The administration buildings, for which plans were prepared by Mathers & Haldenby, architects, will contain laboratories, lecture rooms, libraries and a workshop. A circular building 61 feet in diameter will house the huge telescope, the mirror of which alone weighs 5,000 pounds.

The telescope was ordered over two years ago from the firm of Sir Howard Grubb, Parsons and company, Newcastle-on-Tyne, England, and work on it is expected to be completed within a year. It is of the reflecting type, and the concave mirror which is used instead of a lens in this kind of telescope will have a clear aperture of 74 inches, being fashioned from a disk of glass 76 inches in diameter and 12 inches thick.

Three domes will grace the upper structure of the administration building, and in each of two of these a smaller telescope will probably be mounted, which will be complementary to the great machine in the separate building. The remaining dome will house three astronomical cameras on a single mounting.

Edmonton Journal Alta. Sept. 12, 1932

Toronto University's Observatory

For Canadian Development News

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Winnipeg Free Press Man. Sept. 13, 1932

LAY CORNERSTONE.

RICHMOND HILL, Ont., Sept. 2. —(CP)— Educational and parliamentary dignitaries will gather here tomorrow at the ceremonies attending the laying of the cornerstone of the administration building of the David Dunlop Observatory of the University of Toronto. Canon H. J. Cody, president of the university, will be in charge of the ceremonies.

Brantford Expositor Ont.
Sept. 13, 1932

LOCAL UNIVERSITY FUNDS TRIPLY SAFEGUARDED.

The disappearance of the Manitoba University trust funds was doubtless present in Dr Cody's mind when he reassured his audience at the dedication of the Dunlap Memorial that the trust funds of the University of Toronto are absolutely intact. For though the local seat of learning is a state institution it has attracted benefactions amounting to between four million and five million dollars. This large endowment has come in the main from the late Mr. E. C. Whitney, the Masseys, the Dunlaps and the Rockefeller foundation.

It is reassuring to learn that these trust funds are wholly invested in gilt edged issues—mainly in Dominion of Canada and Province of Ontario bonds, and in the higher grade debentures of Eastern Canadian municipalities. The University of Toronto has no mortgages and no corporation bonds or stocks. The investments have been made with the greatest care, and the securities thus purchased are protected behind a triple wall of caution.

None of the securities is in the hands of University officers. They are all in the safe holds of the Canadian Bank of Commerce, in whose deposit vaults they repose. The securities and the revenue produced by them are subject to continuous auditing by Messrs. Clarkson, Gordon and Dilworth. In addition to this there is a periodical checking of the securities by both the bank and the auditor. In the last analysis the bank is responsible for their safety, and if such a miracle occurred as the disappearance of one of the bonds, the bank would have to make good the loss.

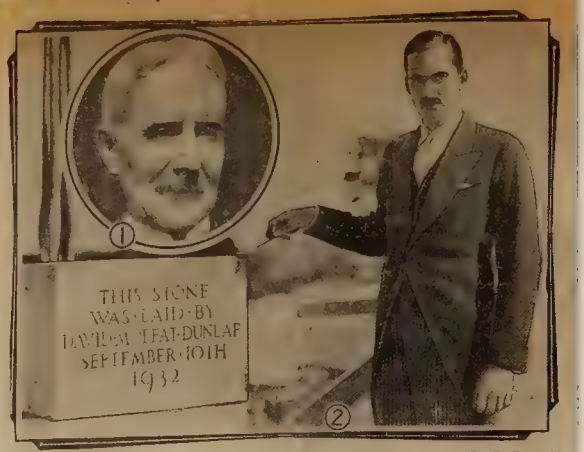
We think it worth while to publish these facts by way of reassuring the public as to the extraordinary precautions taken to protect the trust funds belonging to the state university.

Toronto Mail and Empire
Sept. 14, 1932

President H. J. Cody of the University of Toronto delivered the opening address on Saturday when the corner stone of the administration building, David Dunlop Observatory, at Richmond Hill, was laid by David Moffatt Dunlop, only son of Mrs. Dunlop and the late David Dunlop.

Brantford Witness.
Ont. Sept. 14, 1932

Dunlap Observatory Corner-Stone Is Laid



With impressive ceremony, the cornerstone of the Dunlap Observatory was laid by D M Dunlap at Richmond Hill Saturday. The observatory is in memory of the late D. A. Dunlap, who took a deep interest in astronomy, and is the gift of Mrs. Dunlap to the University of Toronto. (1) Dr. D. Bruce MacDonald, chairman of the board of governors of the university. (2) D. M. Dunlap, son of the late D. A. Dunlap, laying the cornerstone with a silver trowel.

Peterborough Examiner. Ont. Sept. 15, 1932

Build Huge Telescope

Second Largest Telescope In the World To Be Erected Near Toronto

Details of the erection near Richmond Hill, north of Toronto, of the second largest telescope in the world, at an estimated cost of $500,000 has been made public.

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Empress Express. Alta.
Sept. 15, 1932

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Elrose Review Sask.
Sept. 22, 1932

HUGE TELESCOPE FOR UNIVERSITY OF TORONTO

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Wetaskiwin Times Alta.
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Western Parairie Gazette
Glenboro Man. Sept. 15, 1932

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Sarnia Observer. Ont. Sept. 14, 1932

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Qu'Appelle Progress. Sask.
Sept. 22, 1932

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Wapella Post. Sask.
Sept. 15, 1932

Photographs of the Foundation, taken on September 12, 1932. (facing North-West)

HUGE TELESCOPE TO SERVE AS MEMORIAL

Now Being Built in England for Service in Canadian Laboratory

Ottawa, Canada, Sept 28 The second largest telescope in the world is being constructed at Newcastle-on-Tyne, England, for service in a Canadian observatory. This observatory is being constructed as a memorial to the late David A. Dunlap, through funds contributed by his widow and son, and it will be administered by the Department of Astronomy of the University of Toronto The buildings will stand in a park of 177 acres 800 feet above sea level.

The main telescope is of the reflecting type and in place of a lens it will be equipped with a concave mirror to collect light rays from distant bodies and bring them to focus This mirror will have a clear aperture of seventy-four inches and is being fashioned from a disk of glass twelve inches thick and weighing about 5,000 pounds

The order for the telescope was placed two years ago and its construction is well advanced, although it will not be completed for another year. Special machinery had to be built to fashion the bearings of the apparatus and to polish the glass.

The structure to contain the telescope will be a circular building sixty one feet in diameter, surmounted by a metal hemispherical dome revolved by an electric motor The framework will be of steel The walls are to be two feet thick and hollow, and special precautions are being taken to guard against sudden changes in temperature

North Bay Nugget
Ont. Sept. 30, 1932

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

Vol. XXVI, No. 8 OCTOBER 1932 Whole No. 217

THE LAYING OF THE CORNER-STONE

The corner-stone of the Administration Building of the David Dunlap Observatory was laid on the afternoon of September 10. It was a beautiful day, cloudless and pleasantly warm. A rough platform had been constructed from contractor's planks beside the wall, and on it were Mrs. Dunlap, President H. J. Cody of the University of Toronto and a few other friends, while a large number of persons interested in the project, some from a distance, others from the surrounding country, were gathered on the surrounding ground.

The proceedings were in charge of President Cody. In an introductory address he referred to the late David Alexander Dunlap as a man highly respected by all who knew him, sympathetic to all educational and charitable causes, generously spending his income while he lived and at his death leaving noble legacies behind him. Also, he was a keen amateur astronomer, and it was very fitting that his widow, who shared his tastes, should erect to his memory a great observatory. The University has received a number of fine benefactions, and this observatory, in the midst of 179 acres of farmland which will be made into a park, is one of the most notable of these gifts.

At this stage of the proceedings, Mrs. Dunlap presented to Dr. J. Bruce Macdonald, the chairman of the Board of Governors of the University, a document conveying the property to the University

The President then called upon the present writer, who referred to the occasion when he first met the late Mr. Dunlap. It was in May, 1921, at the close of a lecture on Winnecke's comet, during which an appeal had been made for the establishment of a large observatory in the neighbourhood of Toronto. Mr. Dunlap made himself known to the lecturer and said he was much interested in the project of establishing an observatory. The writer kept in touch with Mr. Dunlap, and had hopes that he would provide the observatory, but to the great regret of all he passed away in the

autumn of 1924. Some three years later the writer approached Mrs. Dunlap and asked if she could consider the project. She replied that she would erect the observatory as a memorial to her husband. Ever since then the scheme has been under consideration. The great 74-inch telescope was ordered over two years ago, and the corner-stone of the Administration Building is now being laid. A few months later the circular metal building for the big telescope will be erected on the summit of the hill two hundred feet to the north. A brief description of the rest of the equipment and a statement of the nature of the work to be undertaken were also given.

Then the stone was lowered to its place in the wall, and with a silver trowel presented by Mr. Eric Haldenby, one of the architects of the building, Mr. David Moffat Dunlap assisted the stone to its final position and declared it laid "to the glory of God and the memory of my father".

Following this, President Cody offered a prayer, and then brief addresses were made by Sir William Mulock, Chancellor of the University and Chief Justice of Ontario, Hon. G. S. Henry, B.A., LL.D., Minister of Education and Premier of the Province, and Hon. G. H. Ferguson, B.A., LL.D., former Premier of Ontario and now High Commissioner for Canada in London, Eng. All referred to the magnificent gift of Mrs. Dunlap, not just to the University but to the whole of Canada.

After cheers for Mrs. Dunlap, those present made their way up to a large tent on the summit of the hill, where refreshments were served through the kindness of Mrs. Dunlap.

C. A. C.

The David Dunlap Observatory

[EDITOR'S NOTE. Dr. Chant is associated with Professor C. A. Chant, M.A., Ph.D., F.R.A.S., F.R.S.C., Professor of Astronomy and director of the Toronto Observatories. He has been Editor of the Journal of the Royal Astronomical Society of Canada for many years, he has been president of Section III of the British Association for the Advancement of Science, and has been president of the Royal Society of Canada. He is the author of numerous papers on astronomical subjects, and has been awarded the Lalande gold medal of the Paris Academy of Sciences. He is joint author with Dr. F. W. Merchant of the Ontario School Book entitled "Mechanical Engineering", which has been published in England, Canada and the United States, and translated into three foreign languages.]

We found Dr Chant at his office in the Physics Building, a room which, by the way, seemed to breathe the air of study and research, the walls being covered with photographs and plates, and the shelves lined with books and periodicals relating to the great science of astronomy His desk showed every evidence of the educational workshop, indicating that he has active interest in our daily problems, although he is supposed by some people to have his mind only on the stars We plunged into the work at hand, however

THE OBSERVATORY AT RICHMOND HILL NOW IN PROCESS OF CONSTRUCTION

"Dr. Chant, I had the pleasure of being present at the laying of the corner-stone of the David Dunlap Observatory at Richmond Hill and it occurred to me while listening to your address that a great deal of it would be very interesting to the readers of The Canadian School Journal Would you mind repeating some of it for publication in this Journal?"

"Not at all."

"Might I ask, Doctor, how a memorial of this kind came to be chosen for a man of large business such as Mr. Dunlap?"

"I first met Mr Dunlap towards the end of May, 1921 He was present at a lecture which I gave on Winnecke's comet. This comet returns every six years and on its return in that year calculations showed that it would come extremely close to the earth, indeed that there might be a collision between the two bodies Thus there was special interest in this return of the comet. Toward the close of that lecture I spent some time in advocating the establishment near Toronto of a fully equipped astronomical observatory. I may say that I had been urging this matter for some years before this After the lecture Mr. Dunlap came to me and stated that he was much interested in the project. I was delighted to meet Mr Dunlap and thought that in the coming years he would probably provide the observatory; but after an illness lasting some months he passed away in the autumn of 1924. Three years later I approached Mrs Dunlap, and after referring to my pleasant relations with Mr. Dunlap, inquired if she would entertain the project She replied that it appealed strongly to her and she would consider it Indeed I found that Mrs. Dunlap had shared her husband's astronomical tastes Shortly afterwards she said it would give her pleasure to erect the observatory as a memorial to her late husband."

"As to the site, was that Mrs. Dunlap's choice or had it been in Mr. Dunlap's mind that that would be a suitable spot?"

"As a matter of fact we had chosen a spot on Bathurst Street, north of the City. This property belonged to the City of Toronto and had actually been assigned for our use, but the new project required a new consideration of the best location The entire country within fifty miles of Toronto was carefully examined and the site near Richmond Hill was considered the most suitable of all."

"I understand, Doctor, that there is quite a large acreage with this site. Just what is it?"

"The surveyor computes it to be 178.8 acres."

"What is your intention regarding that great

quantity of land? Is it to be landscaped and made into a park?"

"The portion immediately surrounding the observatory buildings, that is, the entire top of the hill, will be left open and planted with shrubs and flower beds, but the rest will be made into a park The planting and supervision of it will be by the Faculty of Forestry which hope to develop an arboretum in which samples of all trees which can grow in that location will be found."

"What is the precise location, having reference to the main highway?"

"It is fifteen miles north of Lake Ontario and a mile south of Richmond Hill. The hill on which the buildings are being placed is a half-mile east of Yonge Street, the elevation being 800 feet above sea level. As was remarked by Dr. Bruce Macdonald, Chairman of the Board of Governors of the University, at the laying of the corner-stone, it is very appropriate that the building should look out upon the great highway which leads to the North from which comes the means for so noble a gift."

"Now, Dr. Chant, would you just give us in short form a description of these buildings, taking first the administration building which is now under construction and, by the way, I believe that it faces west does it not?"

"This building is 91 feet long by 49 feet wide with semi-octagonal extensions on each end. It is built of Credit Valley limestone with Queenston stone trimmings, both materials being found in Ontario. The architects are Mathers & Haldenby of Toronto, and the design is admired by everyone who has seen it. There will be two stories and a basement. These will contain offices, library, lecture room and laboratories. On the roof there will be three domes; the north dome will contain a 19-inch reflecting telescope which was built at the University. The middle dome will house a 10-inch refracting telescope. In the south dome there will be a battery of cameras of different types."

"And the main building?"

"The other building, which will be on the highest part of the land, will be circular in shape, 61 feet in diameter with a hemispherical dome. This will house a 74-inch reflecting telescope, which, when completed, will be the second largest in the world."

"Could you give us a comparison between that telescope which you say will be the second largest in the world and the one which has been in general use at the University for some years?"

"As a matter of fact, the University equipment has been very meagre, the largest instrument at its disposal being a 6-inch refracting telescope. This is used entirely for teaching purposes. The great reflector will be used entirely for research."

"Then there is really no basis for a comparison between the two instruments?"

"No."

"Well I, although an amateur, would naturally suppose that the lens of that great telescope is its vital part. Would you give us an idea of this great lens and any particulars with reference to it."

"In this telescope the light is collected by a mirror, not by a lens. It is a matter of extreme difficulty to produce such a mirror, both to cast a disc of glass 74 inches in diameter and weighing a couple of tons and then to grind and figure and polish the disc after it has been produced. Great progress has been made as the order for the great telescope was given in May, 1930. The firm supplying it is Sir Howard Grubb, Parsons & Co. of Newcastle-on-Tyne, England."

"I will ask another question that will be probably just as amateurish as the preceding one but one that will be in the minds of a great many. Just how is this observatory connected with the weather forecasting, if at all?"

"It has no connection, although we hope to make meteorological observations at the observatory, but still they will be for ourselves. We will co-operate with the meteorological people but it has nothing to do with the forecasting."

"Would those observations be passed on to the Dominion weather bureau?"

"We shall co-operate with them in every way possible."

"In what other way is this great observatory likely to interest the general public?"

"I find that there is extraordinary interest in the subject of astronomy and I believe the observatory will be one of the outstanding attractions of the City of Toronto."

"Have you any ideas to advance as to how it could be connected with the secondary schools of the Province in order to create a wider interest in the study of astronomy?"

"When the observatory is in operation—"

"Which will be about what date, Doctor?"

"Well it is hard to say exactly, but the administration building will be completed this coming summer and the other one a few months later."

"We shall extend a special welcome to the teachers of the Province and on the occasion of any of their gatherings will make an effort to entertain them. We hope also that the researches carried out will be of sufficient importance to command their interest."

"When you take charge of this observatory, Doctor, does it mean any change in your relations with the University?"

"Not at all, the observatory will be a part of the equipment of the University and will be conducted by the Department of Astronomy."

And so, as it was nearing a lecture hour, we came away, but the thought that remained with us was that one man at last, is about to see fulfilled the dreams of a lifetime.

Air Photograph, looking North-east Oct. 2, 1932

C.N.R.
Narrow road
(North boudary)

Old lane
2 nd. Concession
of Markham Tp.
or Bayview Ave.
(East Boundary)
Farm house and
orchard.

Lane from
Yonge St.

C.N.R. Track
(West boundary of property)

2 nd. coneession
(East boundary)

south boundary

Power line
during construction

Lane from Yonge St

The white strip
is ploughed land

C.N.R.

C.N.R. Track
(West boundary)

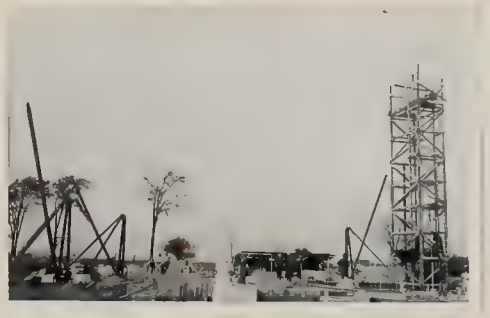
Narrow Road (North boundary)

Air Photograph, looking East. October 2 nd., 1932

East boundary → of property

Air Photograph, looking East, Oct. 2, 1932. Photographs by C.A. Chant
By Airways Limited.

C.A.C. beside the Corner Stone looking E. Sept. 30, 1932



General view, Corner Stone in Front at middle – looking N. Sept. 30, 1932

The local office of Sullivan & Fried General Contractors. looking S.E. Sept. 30, 1932

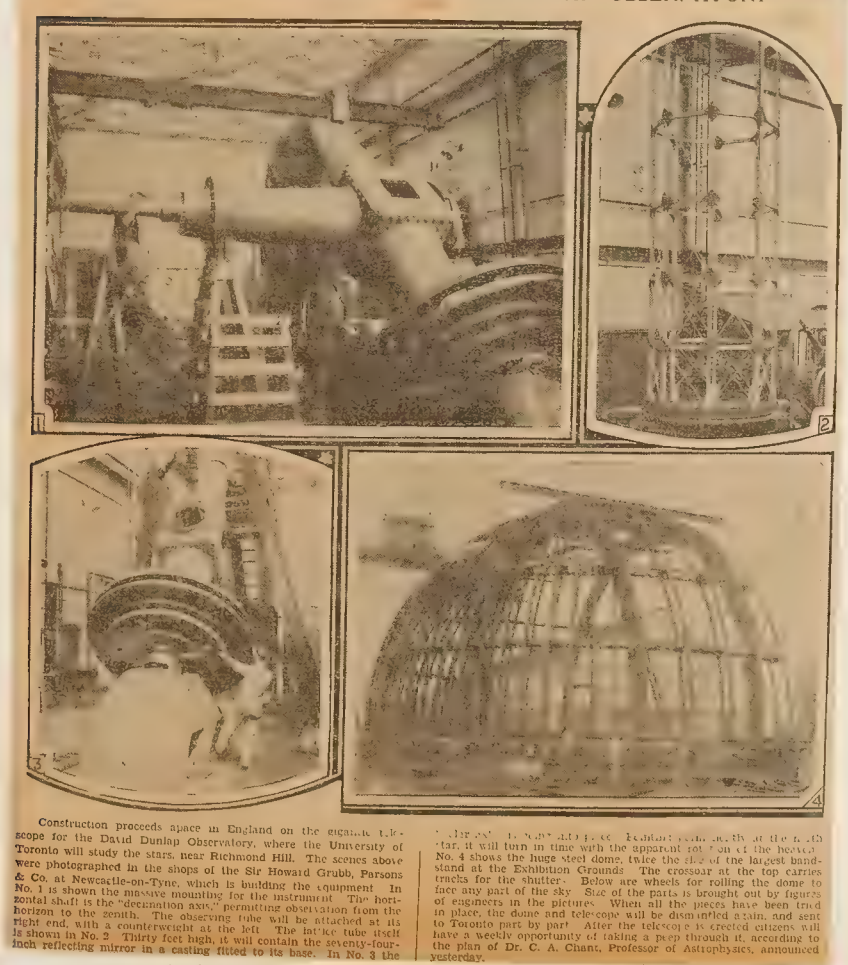
Unloading cut Queenston Limestone; used for trimming. This stone is for the course just above cement foundation. looking N. Sept. 30, 1932

The Front of the Administration Building - note cut stone trimmings. looking N. Oct. 7, 1932

Looking N.E. note the Corner Stone behind derrick. Oct. 7, 1932

Drilling to determine the nature of the earth at the site for the Great Dome, looking S.E. Oct. 7, 1932

ASSEMBLE TELESCOPE FOR GREAT DUNLAP OBSERVATORY



Construction proceeds apace in England on the gigantic telescope for the David Dunlap Observatory, where the University of Toronto will study the stars, near Richmond Hill. The scenes above were photographed in the shops of the Sir Howard Grubb, Parsons & Co. at Newcastle-on-Tyne, which is building the equipment. In No. 1 is shown the massive mounting for the instrument. The horizontal shaft is the "declination axis," permitting observation from the horizon to the zenith. The observing tube will be attached at its right end, with a counterweight at the left. The lattice tube itself is shown in No. 2. Thirty feet high, it will contain the seventy-four-inch reflecting mirror in a casting fitted to its base. In No. 3 the [illegible] No. 4 shows the huge steel dome, twice the size of the largest bandstand at the Exhibition Grounds. The crossbar at the top carries trucks for the shutter. Below are wheels for rolling the dome to face any part of the sky. Size of the parts is brought out by figures of engineers in the pictures. When all the pieces have been tried in place, the dome and telescope will be dismantled again, and sent to Toronto part by part. After the telescope is erected citizens will have a weekly opportunity of taking a peep through it, according to the plan of Dr. C. A. Chant, Professor of Astrophysics, announced yesterday.

Toronto Globe . Out. Oct. 5, 1932

Huge Telescope Will Be Built for Toronto U.

TORONTO, Oct 8 Best known to the world of science and to laymen as the home of insulin the University of Toronto will shortly have new claims to fame in the field of astronomy. Work has started on a new observatory in the Richmond hill section of this city which, when finished next year, will house one of the largest telescopes in the world.

The huge sixty one inch instrument to be finished in England within the year will be the centre of the 'David Dunlap observatory" costing over $500,000 when completed.

The new telescope will be of the reflecting type, with a clear aperture of seventy-four inches. The disk of glass seventy six inches in diameter and a foot thick, weighs 5,000 pounds.

The Northern Mail. The Pas. Man. Oct. 8, 1932

Telescope Project Nears Completion

In conjunction with the gift of the second largest telescope in the world, donated to this university, three smaller telescopes are to be installed, Dr. Chant, head of the astronomy department informed *The Varsity*. The Dunlop memorial telescope is to be housed in a separate observatory and the three smaller ones in a single building with three domes. This building will also serve as an administrative building and will contain the observatory offices.

Completion of the project is expected within the year. The architects drawings exhibit buildings of beautiful design, a notable addition to the university property. Completion of the project is expected within the year. Following the customary procedure, the observatories will be open for inspection to the public for one evening.

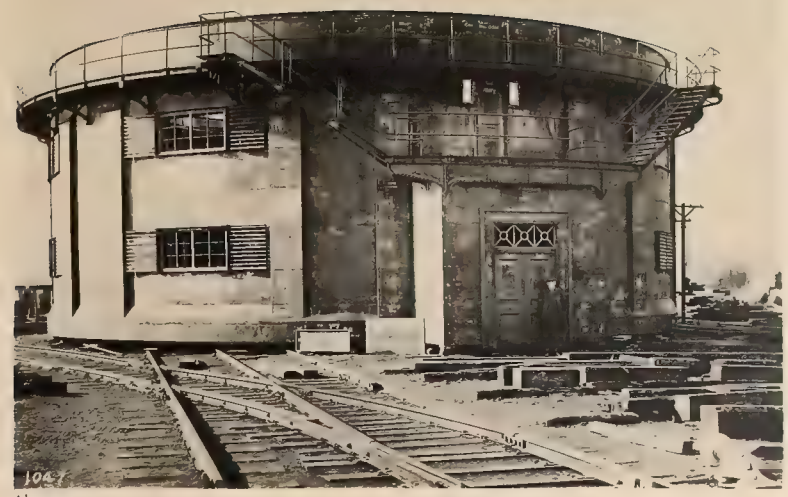
Dr. Chant has promised more detailed information at a latter date including technical details and sketches.

This group of four telescopes will assist immeasurably in the work of the department of astronomy and will lend a distinction to the University of Toronto accorded to none other in the world.

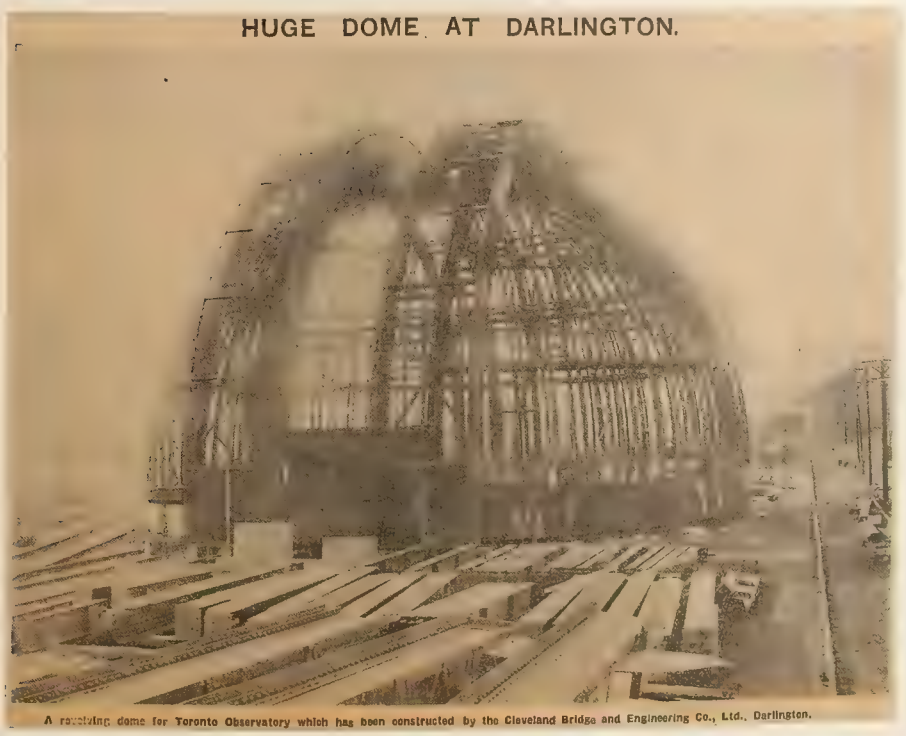
The Varsity Undergraduate Newspaper Toronto Oct. 7. 1932

Toronto 61-ft. Dome. View taken during construction at Darlington, June 1932

Two views during the construction of the 61-foot Dome at Darlington, Eng.
The steel girders in front are for the floor of the building. August 1932



Circular Steel Building erected at Darlington before being shipped to Toronto April -1933



From the Darlington "Northern Despatch" August 29, 1932

Looking E. showing Front of Building Front Door behind derick – Oct. 14, 1932

Looking N.W. The shanty at left front contains the steam hoist. Oct. 14, 1932

Looking S.E. showing Front and part of N. end. Oct. 14, 1932

Looking N.E., Corner Stone is 1⅜ in from left edge. Oct. 14, 1932

C.A.C. in S.W. Corner office Oct. 14, 1932

The Front Door – Oct. 14

The Front Door-Oct. 21, 1932

Looking S.E. showing N.W. corner
Oct. 21, 1932

Front and S. end of Building–
Oct. 21, 1932

S.W. Corner – corner stone
is dark. – Oct. 21, 1932

Front of Building, looking N.E.
Oct. 28, 1932

North end and Front of Building
Oct. 28, 1932

Looking N.W. toward Richmond Hill
from Building Oct. 21, 1932

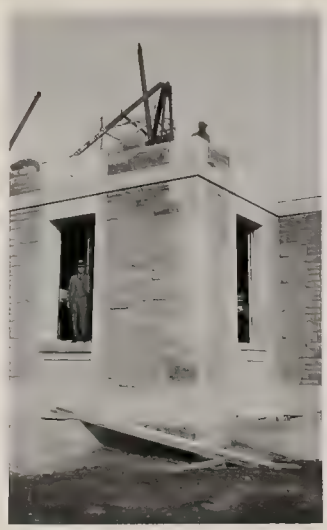
Looking S.W. from second floor of Build-
ing. Oct. 21, 1932

South End & part of rear. Oct. 28, 1932

Preparing to pour upper floor Oct. 28, 1932

Stone-cutters Wilson (left) and Boyle. Oct. 28

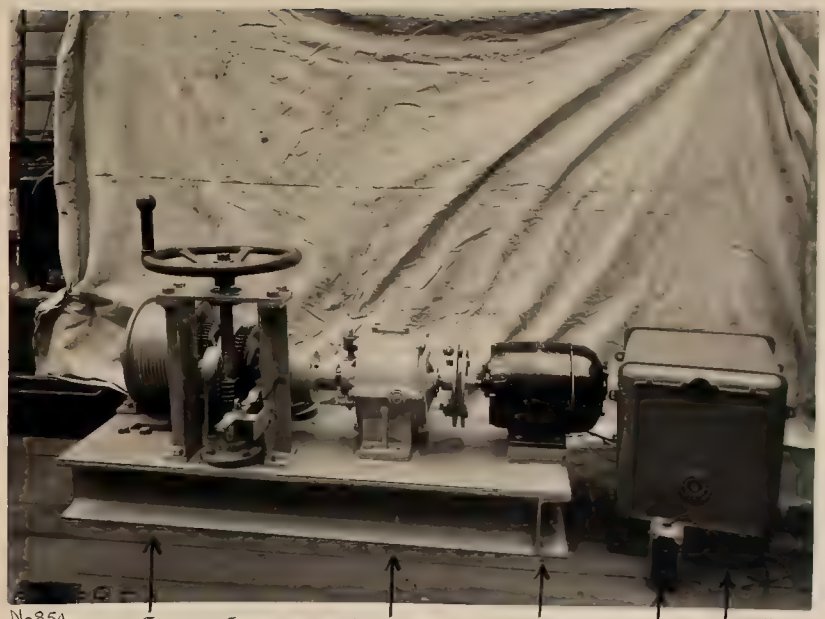
S.W. corner - note corner stone. Oct. 28.



S.W. Corner - note upper portion. Nov. 4

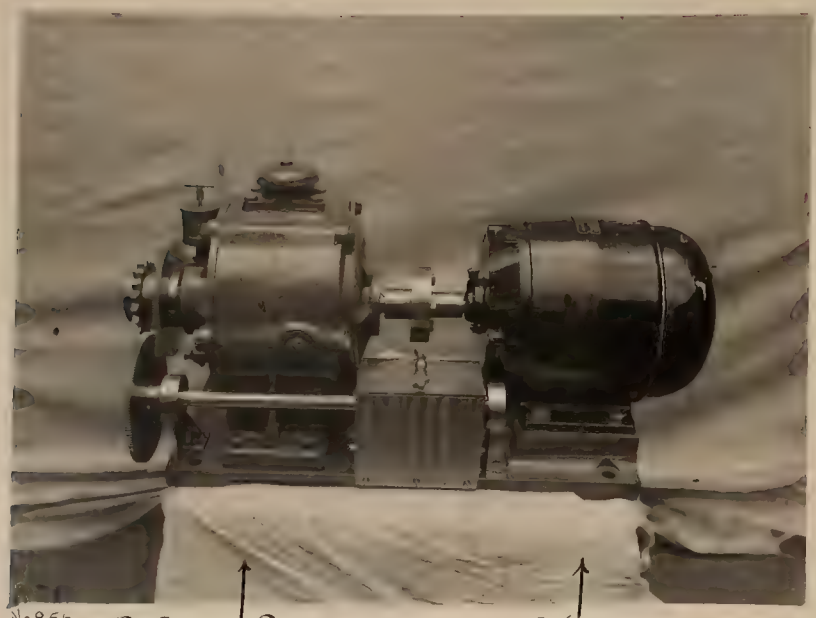
Northwest portion of Building Nov. 4, 1932

Northerly part of Front Nov. 4, 1932



Gear for Operating the Shutter of the 61-foot Dome (in shop) the hand-wheel can be used if the electric power is off – September, 1932

Gear for Operating the shutters, in place in Dome (at Darlington) Oct. 1932
View from Motor end.



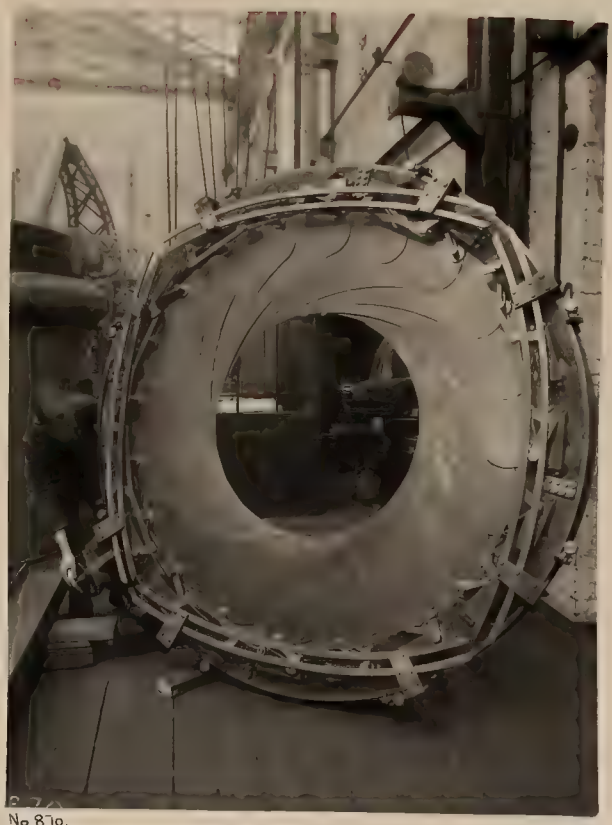
Gear for Operating the Wind-screen of the Dome (in shop) Sept. 1932

Gear for Operating the Wind-screen, showing Spindle in place in Dome Oct., 1932

Gear for focussing the Cassegrain Mirror - The mirror is moved back or forth by a motor controlled from the bottom of the lattice tube - Sep. 1932

View of Shutters of the great 61-foot dome, from inside the dome, during construction. October 1932

N-601



No.870.

No.871

Three views of the iris Diaphragm, (which is within the centre-piece of the tube of the telescope.

(see page 86)

869. The diaphragm wide open

870. Half closed.

871. At minimum aperture.

Nov. 1932

No.868.

View in the shop at Newcastle. The lattice tube is in the right foreground. In the middle the polar axis is seen mounted, with the declination axis inserted & with the declination counterweight in place. The centre-piece is on the floor to the right and in front of it is.... the iris diaphragm - In the background is the Greenwich 36-inch reflector, and in the foreground is the mounting for the twin 16-inch astrographic refractors, for Leyden Observatory Nov. 32

Looking N.W. Hoisting-engine house at night. Nov. 4, 1932

The upper floor, looking N. some of the floor poured; preparing another portion (at left)
Nov. 4, 1932

The men mixing the cement at rear of building - looking S.E. Nov 4, 1932

Facing S.W. Showing Front and North End – Nov. 12, 1932

Facing N.W. Showing Rear and South End – Nov. 12, 1932

Facing S.W. Showing Rear and North End – Nov. 12, 1932

Building the inner Wall of the Second Story – looking N. Nov. 12, 1932

South-west Corner and Front. Nov. 12, 1932

Front Door – Nov. 12, 1932

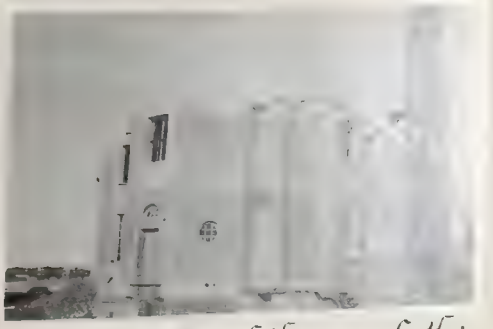
The Front Door–Nov. 22 1932
(Mrs. Chant in door)

The S.W. Corner and
the Front – Nov. 22, 1932

The North End and the Front
Nov. 22, 1932

The sign in the Lane – Nov. 26, 1932
(Mr. F. Jno. Bell's car; a bitter cold day)

Preparing the forms for the Cement
Roof. (Front to left, looking N.) – Nov. 26, 1932



The south end and the rear of the
building – Nov. 26, 1932

The Front Door and Portico - Nov. 30, 1932

The S.W. Corner and Portco - Nov. 30, 1932

The S. part of the rear. Nov. 30 (men pouring cement roof

The Rear of the Building. Nov. 30, 1932

Pouring the Cement Roof, looking S. (Front at right) - Nov. 30, 1932

Pouring the Cement Roof - looking N. (Front at left) Nov. 30, 1932

Front Door – Dec. 22, 1932

Portico – Dec. 22, 1932

S.W. corner and Portico
Nov. 22, 1932

South End – Dec. 22, 1932

View of North End and Front.
Dec. 22, 1932

View of South End and Rear
Dec. 22, 1932

Photographs taken about Dec. 27, 1932

Mrs. D.M.D. at Portico

Mr. and Mrs. D.M.D.

Front of Building

Another view of Front

No 888.

Shutters Closed Jan. 1933

Views of the two Domes 18 feet in diameter, being the north and south domes for the Administration Building

No 889.

Shutters Open Jan. 1933

The two domes in the shop at Walker Gate, Newcastle

Jan. 16, 1933

Administration Building, Front and South end

Jan. 16, 1933

Administration Building Rear and North end

University of Toronto
TORONTO 5, CANADA
DEPARTMENT OF ASTRONOMY

January 21, 1933

Dear Mrs. Dunlap, —

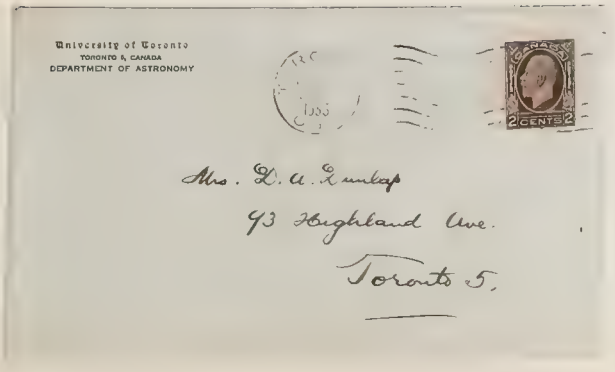
As I told you over the 'phone this morning I have had discussions with Mr. Bell about the big disc of glass, and I prepared a memorandum for him giving my views on the present condition of affairs. He prepared a memorandum for the firm in England and sent me a copy. Herewith I enclose copies of the two documents. They summarize the negotiations up to the present. I hope to have something definite to report on your return from Bermuda.

Very sincerely yours

C. A. Chant

P.S. I am sending similar copies to Mr. Holden.

C.A.C.



Mrs. D. A. Dunlap
93 Highland Ave.
Toronto 5.

Photographs taken February 16, 1933

View facing East. Feb. 16, 1933

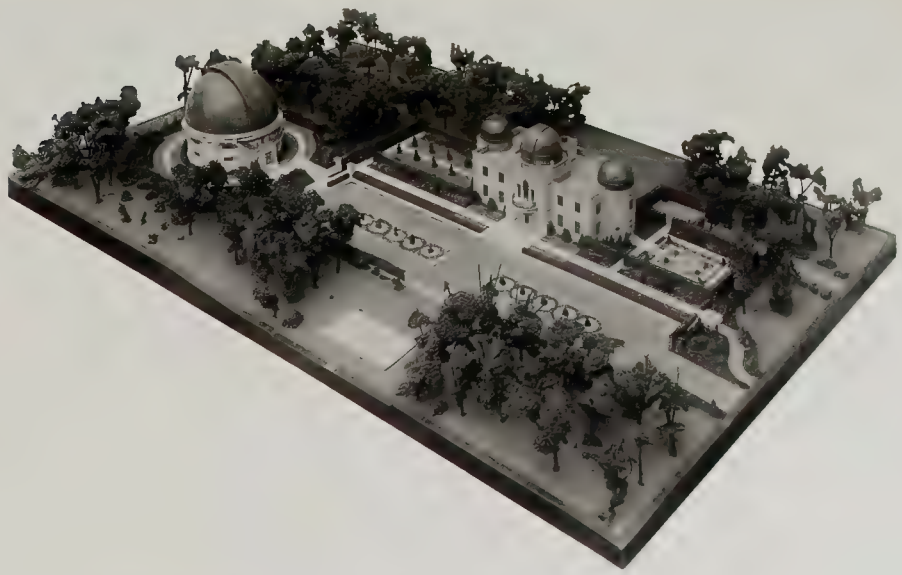
View facing Southeast. Feb. 16, 1933

View facing Northeast Feb. 16, 1933

Sir Frederic Stuart

C.A.C.

two views of Portico - Feb. 16, 1933



Model of the Observatory constructed in the offices of Mathers and Haldenby and shown at the Exhibition of the Ontario Association of Architects, February 1933.

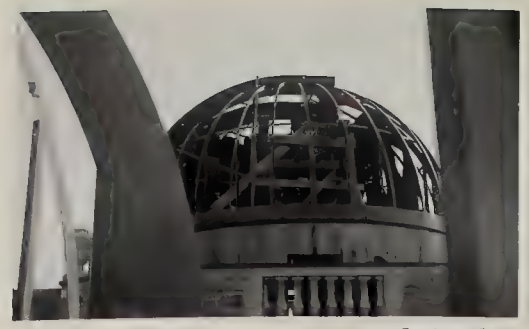
View of north end, and rear of building showing cases containing the three domes. Mar. 1, 1933

March 1, 1933

March 1, 1933

Two views showing cases containing the three Domes as they arrived from England

March 16
Central Dome. The Tarpaulin protects the men from the Wind



March. 16
South Dome, as seen from Central Dome

Front of Building, showing Domes, Mar. 16

North Dome, showing cement wall and Dome partly erected on it, Mar. 16

Another view of the Domes

Preparations made to excavate for pier for 74-inch Telescope, Mar. 16, 1933

Photographs taken March 22, 1933

Dropping a heavy weight on the frozen earth to break it for the excavation for the great pier.

The bucket of the steam shovel descending for a load of earth

The loaded bucket rising – looking N.E.

The bucket in the air – looking N.W.

The ironwork of the Domes erected

The Library on Mar. 22

Photographs taken April 4, 1933

Covering the S. dome with "agasote" and copper

Another view of S. dome
C.R. Chalker (inspector, left)
E.W. Haldenby (right)

Reinforcing iron at bottom of excavation

Ready to pour the cement

Bringing in water from Richmond Hill through the mud

View of steam shovel, and materials for cement and excavated earth, looking N. April 4, 1933

Photographs taken April 21, 1933

Two views, showing the North and South Domes almost completed and the centre one well forward

The North dome : the cement wall yet to be covered with copper

C.A.C. beside one of the stone urns, the north dome in background

Looking southeast

Looking Northeast

Two views showing progress on the cement pier for the 74-inch Telescope

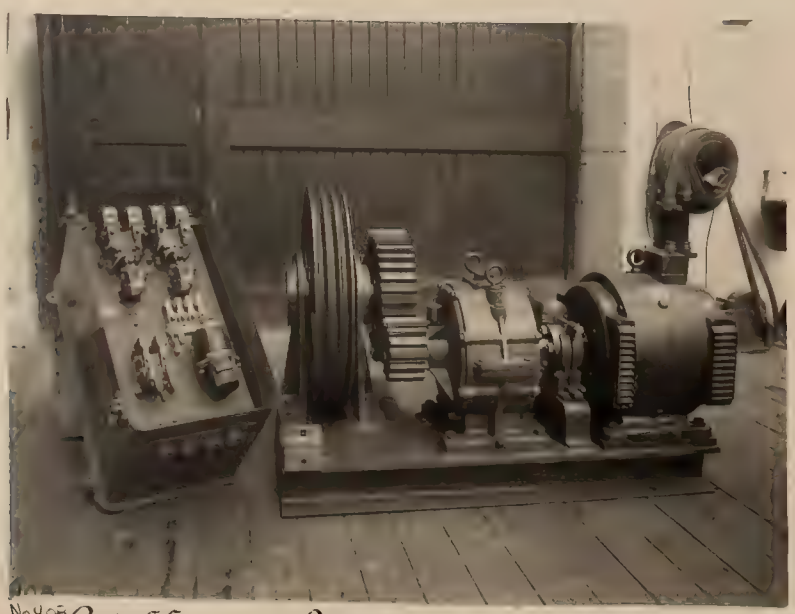
Four upper photographs taken April 27. 1933

View showing domes completly covered

Steel rods on left, are reinforcements for elevator pit, south part of pier up to surface of ground S.E. view

Showing W. side of N. part of pier. looking N.E.

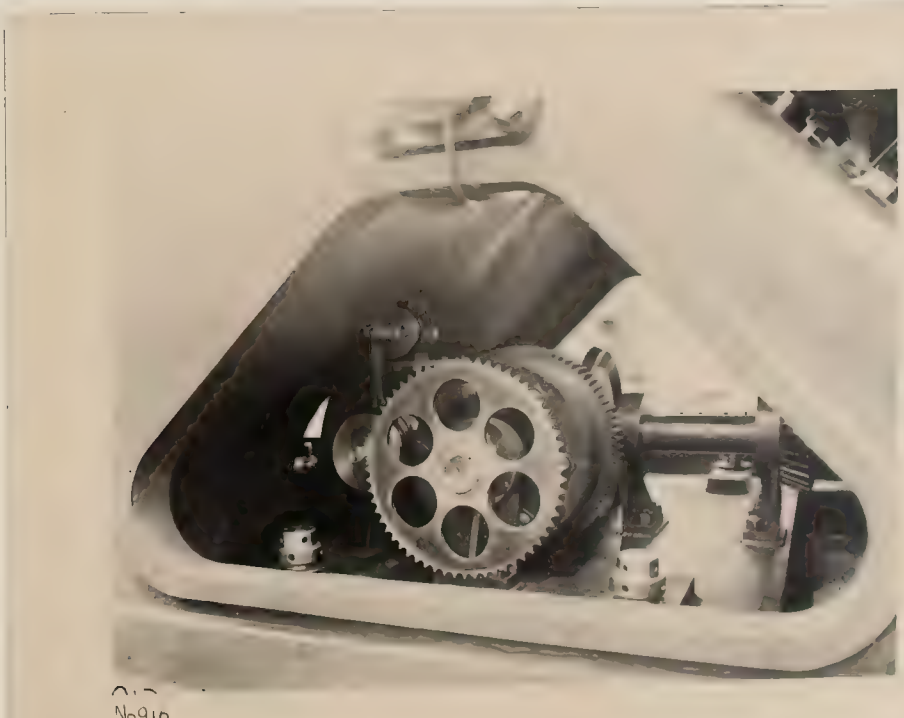
North end and part of front of Building



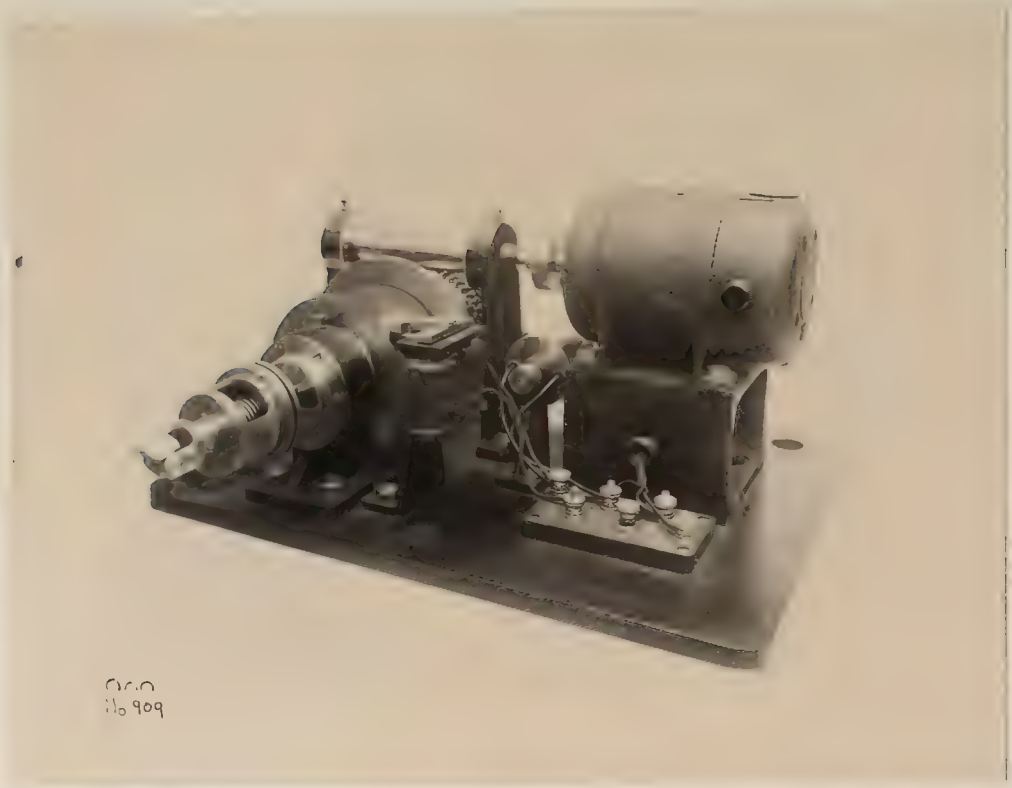
No 408 Control box Reducing gear Motor

Gear for turning the 61-foot dome — (in England, April 1933)

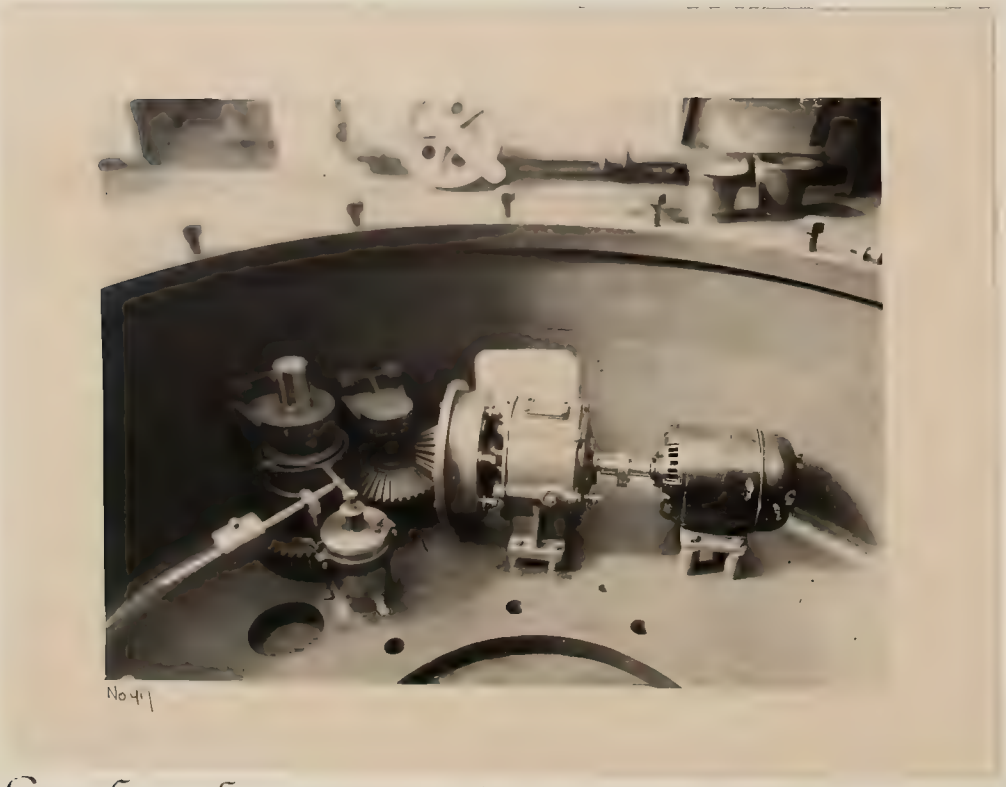
Gear for quick motion in right ascension, View from motor end April 1933



Gear for quick motion in right ascension. View from sprocket wheel and showing solenoid — April 1933



Gear for two speed slow motion of telescope in declination — April 1933



Gear for quick motion in declination, assembled inside the counterweight — April 1933

Photographs taken May 10, 1933

Looking Southeast

Looking Northeast

The Administration Building

Workmen covering with copper the wall of the central Dome. (from S. Dome)

Showing progress on the great pier, looking S.E. Part of wooden form removed.

Looking Northeast

Looking Northwest

The circular wall is part of the form for the cement wall of the building - Progress on the Great Pier and the Wall of the Building. May 10, 1933

Photographs taken May 16, 1933

Looking Northeast

Looking Northeast

Showing earth filled in around the great pier and progress made on the cement foundation for the wall of the Building

Looking Southeast

The circular wooden forms is for the cement foundation of the building

The electric motor for rotating the central dome.

Showing Progress on the Portico

The Southeast corner of the Building May 16, 1933

Photographs taken May 22, 1933

Looking N.W. Steam shovel at left is filling in around the pier; that in front is being used for grading.

Looking S.E. Showing the pier rising above the ground, about 20 feet in this view.

Looking N.E. Circular foundation for building in front.

Steam shovel being used for the grading around the Administration Building.

Another view, facing East.

View of Building facing N.E. May 22, 1933

Photographs taken May 29, 1933

Facing N.W. From second story window of Administration Building.

Facing N.W. View from parapet of Administration Building

Facing N.E. The structure at left is for hoisting and pouring the cement.

Facing N. slightly E.

Showing walk to South Dome

No 921

View showing the polar axis of the 74 inch Telescope with declination axis in place, and centrepiece ready to be hoisted into position

May 1933

No 922

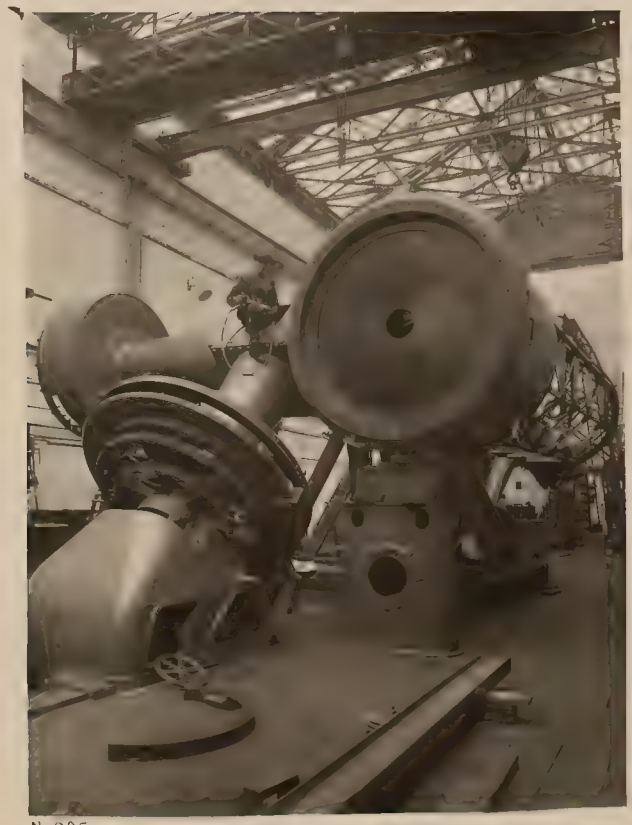
The centrepiece in place

Newcastle-on-Tyne, May 1933

No 923

The 74-inch Telescope

View taken near the upper end of the tube. May, 1933



No 925

View from back of centrepiece. The mirror cell is removed to show the iris diaphragm.

Newcastle-on-Tyne. May 1933

Looking N.E. Progress on pier June 1, 1933 J.A. Pearce

Looking N.E. Progress on pier June 1, 1933

At the Front Door June 1, 1933
C.A.C. Mrs. C.A.C. J.A. Pearce

The Pier on June 6, 1933

Sir Robert Falconer, A.D. Le Pan
June 6, 1933. Robert Falconer (son)

A.D. Le Pan | C.A.C.
June 6, 1933 Sir Robert.

The Pier on June 13, 1933

View of Pier from second story window of Administration Building June 13, 1933

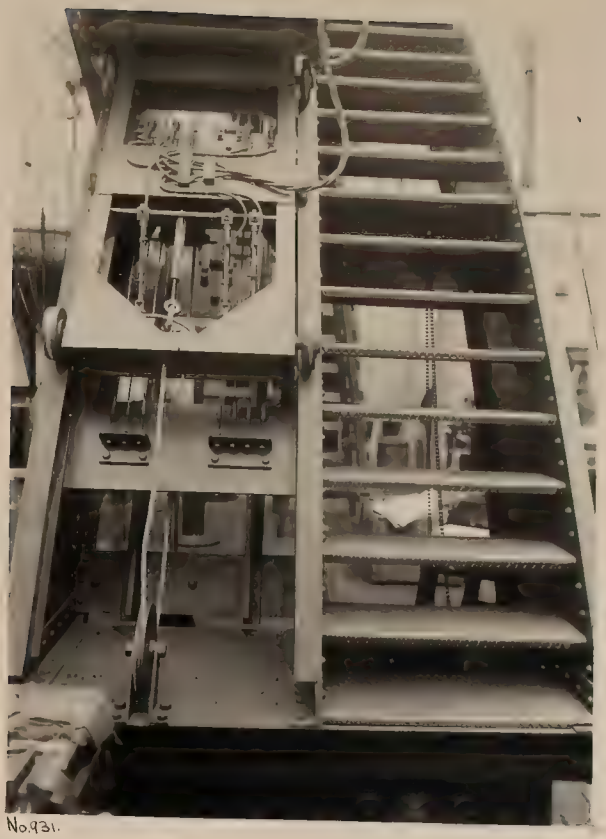
No 430

This bridge is to enable the observer to place himself near the upper end of the Telescope tube.

View of the moving bridge for the 61-foot dome~This bridge may be moved to left or right and the observer on the carriage may be drawn up or let down. At Newcastle, May 1933

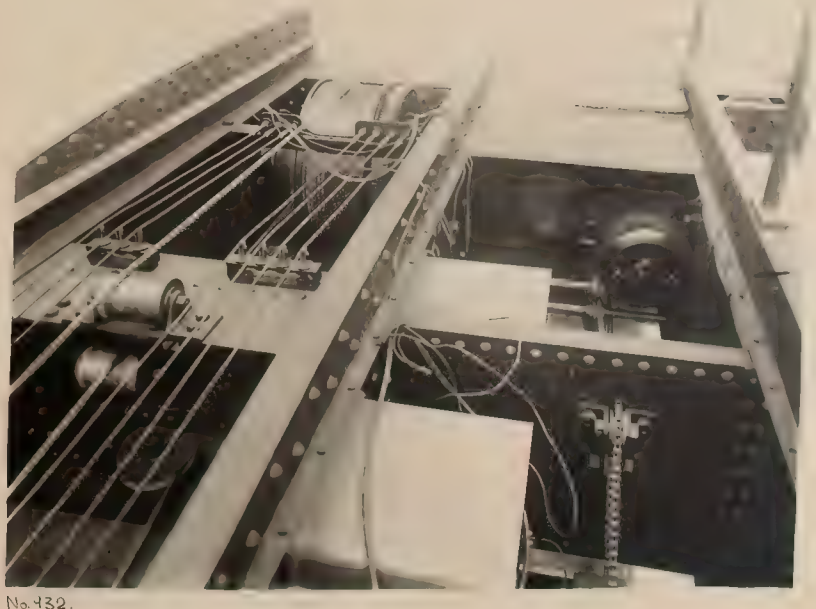
No 430.

View from upper end of bridge, looking down it. June 1933.



No. 931.

View of lower part of Bridge, below the carriage June, 1933



No. 432.

View of upper part of bridge, above the carriage. The drum and cable draws up and lowers the bridge. The electric wires are for the various motors June. 1933

Toronto Wireless of 1899 Sent Message Across Room

Prof. Chant Recalls First Canadian Demonstration at University.

SENT FIRST WIRELESS.

PROF. C. A. CHANT

68 years old yesterday, who directed operations when the first wireless telegraph message was sent in Canada, in November, 1899.

On the eve of his 68th birthday, which he observed yesterday, Professor Clarence A. Chant laughed merrily when he was reminded of an important experiment in 1899, during which the first wireless telegraph message was transmitted and received under his direction.

That message was carried a distance of only a few feet from one side of a lecture room to the other—but it received headlines in newspapers and the plaudits of the assembled savants of the Canadian Institute.

It was in a lecture room of University College and under the direction of C. A. Chant, then lecturer in physics and now professor of astrophysics, that "wireless" made its debut in Canada. The first word sent spelled "unit-ersity," and a few was the theory of wireless telegraphy that many weeks had been spent in setting up of Canada's first wireless apparatus.

In the issue of The Mail [illegible] of Nov. 25, 1899, mention [illegible] made of Professor C[illegible] ress in experimenting [illegible] telegraphy and of the lecture he was going to give that night at Saturday to the Canadian Institute.

"Telegraphing without a wire," was the "head" to the report, which stated that on the previous Thursday Profes.or Chant's apparatus had been completed and the first messages transmitted and received across the "physics theatre" room 14 in the west wing of University College.

The apparatus which carried the message was the first set-up for this purpose in Canada. The messages were taken on an ordinary Morse register and the first word spelled out was "university," the report read.

In a report, appearing the following Monday, Professor Chant's demonstration to the Canadian Institute is recorded. It states in part: "Mr. Chant expressed doubts as to whether it would ever be possible to send messages to the west across the ocean, although as he pointed out it is necessary to speak with much caution of anything relating to the science of electric telegraphy."

Professor Chant yesterday corroborated the opinion expressed by the old report that his apparatus was the first transmitter and receiver of wireless telegraphy in Canada.

"Yes," he agreed, "we've gone a long way since then. I don't know how long we spent on preparing the apparatus—certainly it took a great deal of time. And I believe that ours were the first messages sent in Canada."

Mail and Empire
June, 1933

DUNLAP OBSERVATORY NEARING COMPLETION

Work on Telescope is Progressing in Two Hemispheres.

TO USE NEW GLASS

Steel Building, Built in England, Dissembled and Shipped Here.

While workmen of two continents are engaged on the intricate work of producing the separate units which will some day join to form one of the most powerful and delicate reflecting telescopes in the world, the future home of the giant instrument is nearing completion just outside Toronto.

Only the finishing touches are needed to complete the administration building at the David Dunlap Observatory on North Yonge Street. Already the huge cement pier, a masterpiece of concrete construction, extending from 30 feet underground to 50 feet above, awaits the gigantic telescope. Within a month, the circular steel building which will house the entire assembly, will be nearing completion.

This building alone, and its circular revolving dome, weighs 180 tons. The unit was built and assembled in England. It was then dissembled, packed and shipped and will arrive at a Toronto dock before July 1. It will then be trucked to the site and re-erected and will be completed in August. It will then encompass the immense concrete pier on which the delicate telescope will repose.

Work on the latter is progressing in two hemispheres. In England the construction of the telescope is being pressed. After experiments in England to produce glass for the large mirror, observatory officials learned of research in the United States on pyrex glass for such mirrors. As a result, plans made three years ago when the order for the telescope was given for the mirror's production from a type of crown glass were abandoned.

Pyrex glass expands much less under rises in temperature than any other form of glass and is very desirable for such mirrors. The mirror in the big telescope must be ground from a sheet of glass 76 inches in diameter and 12 inches thick, and work is now progressing on this sheet of glass at the Corning Glass Works, Corning, N.Y. It will then be shipped to England for grinding and polishing and then will be shipped to Toronto for fitting in the telescope mounting, which by Summer of 1934 will be ready to receive it. Some idea of the size of the mirror is evidenced from the fact that it will weigh two and one-half tons.

The telescope itself will weigh 65 tons when mounted on the pier, yet the entire instrument will be balanced and adjusted to the accuracy of a chronometer. The mounting for it will be shipped from England in August, accompanied by a representative of the manufacturers who will superintend the task of erecting and adjusting it.

In the small dome of the observatory the 19-inch telescope is already installed but not yet mounted. The refracting telescope for the central dome and the astronomical cameras for the north dome will be supplied later.

Mail and Empire
June 19, 1933

WORK CONTINUES (1933) ON OBSERVATORY

Steel Building to House Telescope Comes From England

LARGE PIER ALSO READY

Considerable progress has been made recently on the David Dunlap Observatory. The stone administration building is almost completed. On the exterior some iron railings have yet to be put in place and a little painting has to be done. The grounds about have been graded. Within the building, a small amount of carpentering work and painting remains. The nineteen-inch reflecting telescope, which will occupy the south dome on the building, is within the dome, but not yet mounted. The refracting telescope for the central dome and the astronomical cameras for the north dome will be supplied later.

Building and Dome by Sea.

The cement foundation for the sixty-one-foot circular steel building, which will house the great reflecting telescope, is now ready. The building itself and its revolving dome were constructed and temporarily erected in England. They were then taken to pieces and put on a steamship, which will deliver them at the dock in Toronto before July 1. They weigh 180 tons. They will be taken by truck to the site and erected. The building will be completed in August.

The immense pier for the telescope is also ready. It extends thirty feet into the earth and rises about fifty feet above the ground. It is a masterpiece of cement construction. The mounting of the telescope is ready and will be shipped from England in August. It will be erected on its pier in September. Although the telescope weighs fifty-six tons, it is constructed with the accuracy of a chronometer, and to mount and adjust it demands special skill and care. A representative of the makers will be on hand to direct operations.

Pyrex Disc Is Ordered.

Unfortunately the large mirror, which is the critical portion of the instrument, is not ready. The delay in producing it is due to the difficulty in obtaining a disc of glass for it. This disc has to be 76 inches in diameter and 12 inches thick, and its weight is nearly two and a half tons. When the order for the telescope was given three years ago it was expected that the mirror would be made from a kind of crown glass, but while the unsuccessful efforts to produce the disc were being made in England experiments in casting large discs from pyrex glass were carried out. This glass expands with rise of temperature much less than ordinary glass and it is much more desirable for a telescope mirror. When it was learned that a disc could be obtained from pyrex glass, the firm which is making the telescope, being anxious to supply an instrument of the very highest quality, ordered a pyrex disc. It is being produced at the Corning Glass Works, Corning, N.Y., and in September will be shipped to England, there to be ground and polished. If no special difficulties are encountered the mirror may be ready in the summer of 1934. When completed it will be shipped to Toronto and will be placed in the telescope mounting, and the instrument will begin its career of astronomical research.

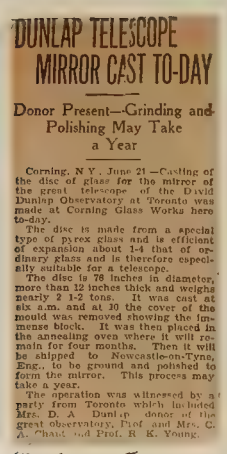
Toronto Globe
Statement by C.A.C. June 20, 1933

E.W. Haldenby, R.L. Blackburn
Mrs. Dunlap, Mrs. Blackburn
Mrs. W.R. Hodge, June, 1933

Looking N.W. from roof of administration Bldg.

Looking N.E. June 26, 1933

Two views of the Great Pier



DUNLAP TELESCOPE MIRROR CAST TO-DAY

Donor Present—Grinding and Polishing May Take a Year

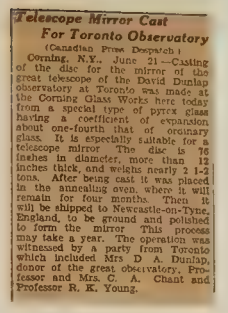
Corning, N Y., June 21.—Casting of the disc of glass for the mirror of the great telescope of the David Dunlap Observatory at Toronto was made at Corning Glass Works here to-day.

The disc is made from a special type of pyrex glass and is efficient of expansion about 1-4 that of ordinary glass and is therefore especially suitable for a telescope.

The disc is 76 inches in diameter, more than 12 inches thick and weighs nearly 2 1-2 tons. It was cast at six a.m. and at 10 the cover of the mould was removed showing the immense block. It was then placed in the annealing oven where it will remain for four months. Then it will be shipped to Newcastle-on-Tyne, Eng., to be ground and polished to form the mirror. This process may take a year.

The operation was witnessed by a party from Toronto which included Mrs. D. A. Dunlap, donor of the great observatory, Prof. and Mrs. C. A. Chant and Prof. R. K. Young.

The Star. June 21, 1933



Telescope Mirror Cast For Toronto Observatory

(Canadian Press Despatch)

Corning, N.Y., June 21.—Casting of the disc for the mirror of the great telescope of the David Dunlap observatory at Toronto was made at the Corning Glass Works here today from a special type of pyrex glass having a coefficient of expansion about one-fourth that of ordinary glass. It is especially suitable for a telescope mirror. The disc is 76 inches in diameter, more than 12 inches thick, and weighs nearly 2 1-2 tons. After being cast it was placed in the annealing oven, where it will remain for four months. Then it will be shipped to Newcastle-on-Tyne, England, to be ground and polished to form the mirror. This process may take a year. The operation was witnessed by a party from Toronto which included Mrs. D. A. Dunlap, donor of the great observatory, Professor and Mrs. C. A. Chant and Professor R. K. Young.

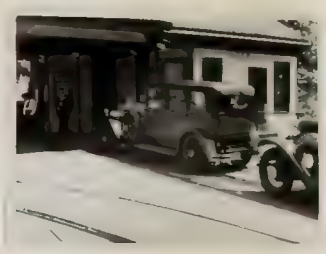
The Globe, June 22, 1933

The hotel where we stayed.

On the way to Corning N.Y. to see the pouring of the Glass Disc for the Mirror. June 20, 1933

On the Lewiston Bridge. Can. End.

a little farther on the Bridge



on the Bridge, U.S. End.

Mrs. Chant & Mrs. Dunlap ↑our car↑

Mrs. Dunlap & Mrs. Chant

About to leave Dansville

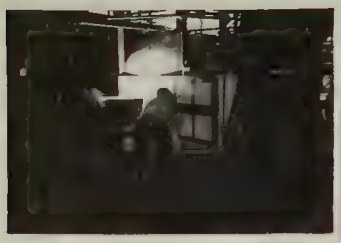
Main Street, Dansville Looking N.

The above photographs were made from negatives taken with a Leica Camera.

Payne (chauffer)

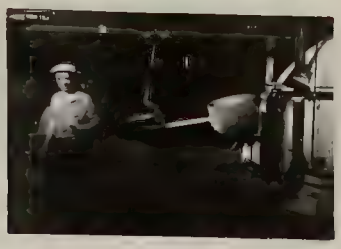
The main Street, Dansville, Looking S.

Views at the Pouring of the Disc for the Mirror



Taking a ladle of glass to the mould.

Thrusting the ladle into the mould.



Bringing back the empty ladle

The above pictures were taken about 7.a.m.

Pushing carriage (with mould) away after bee-hive cover of mould had been removed 1.30 p.m.

View of the glass disc in the mould 1.30 p.m.

Mrs. Chant F. Cameron Mrs. Dunlap Mrs. Hostetter

O.A. Sage P.H. Mitchell F.J. Bell Hostetter

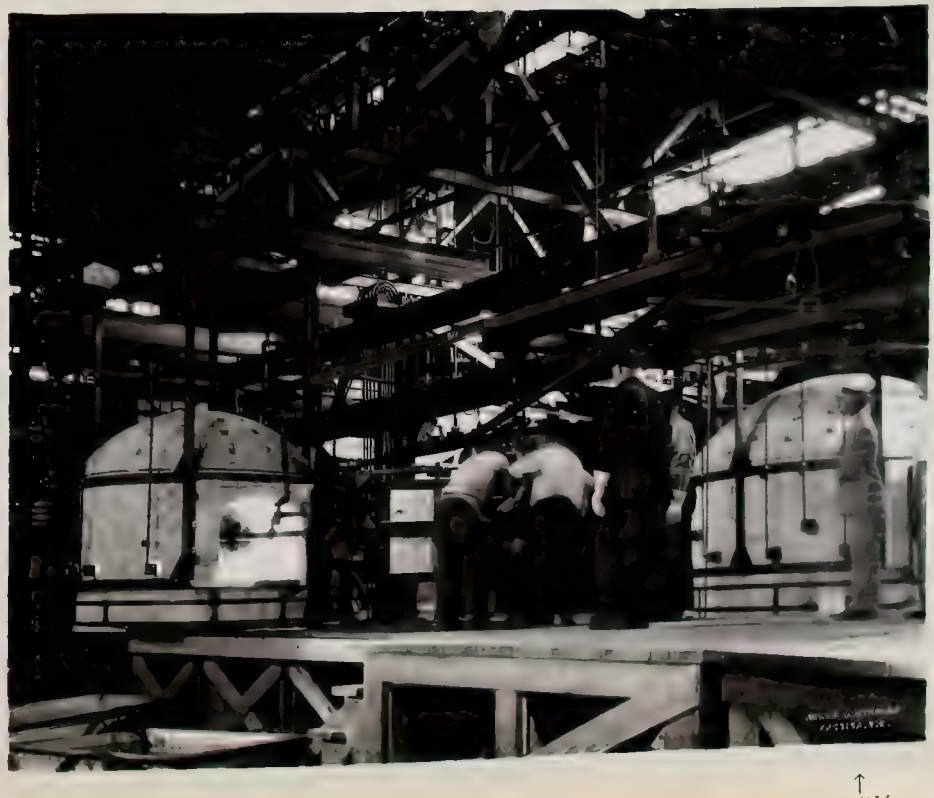
O.A. Sage R.K. Young P.H. Mitchell F.J. Bell

R.K. Young F.J. Bell. P.H. Mitchell

Views at the Breakfast table, Corning Glass Works
7.30.a.m. June 21. 1933

View showing the interior of the mould for the disc of glass, and also the beehive covering.

The core projecting upward is to produce a round hole in the disc.

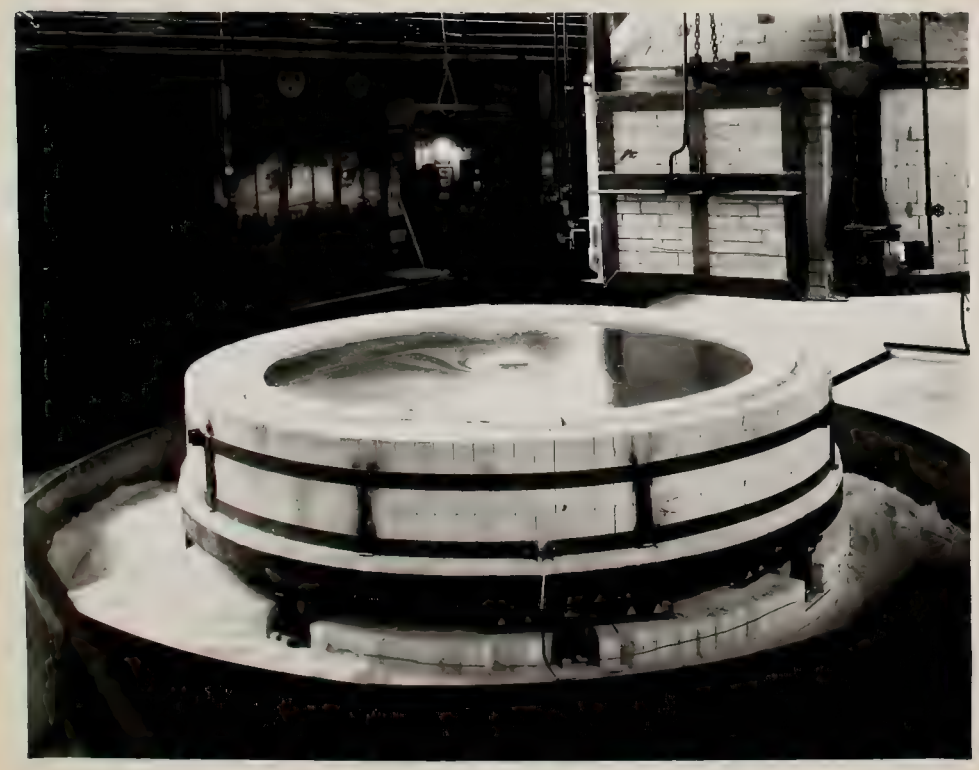


View showing workmen inserting a ladle full of glass and pouring it into the mould.

R. K. Young.

The 76 ½ inch disc — A Mould Cover — An Annealing Oven

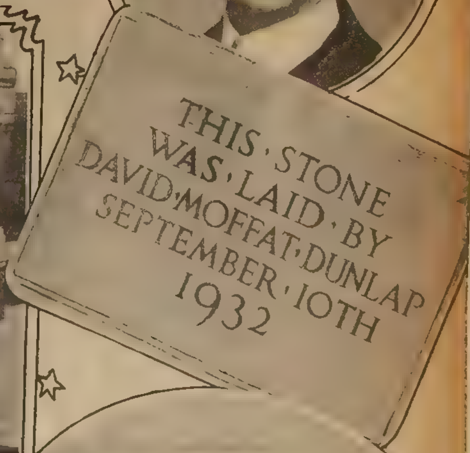
View in the Corning Glass Works



View of the Disc, 76½ inches in diameter and 13 inches thick, before being placed in the Annealing Oven.

THE EVENING TELEGRAM, TORONTO, SATURDAY, JUNE 24, 1933

Tracking the Stars!



Above is the giant telescope of the Dunlap Observatory, photographed during the course of construction at Newcastle-on-Tyne, England. While English workmen were fashioning this largest telescope in the Empire, Toronto workmen were constructing the base on which it will be placed at the Dunlap Observatory, North Yonge Street, shown at the right.

ADMINISTRATION BUILDING OF THE DUNLAP OBSERVATORY, NORTH YONGE STREET

Top—Professor C. A. Chant, who will be in charge of the Observatory. Centre—The corner stone of the Observatory, which was established as a memorial to the late David A. Dunlap. Below—The dome-topped observatory far away through the trees as seen by Yonge street motorists—(Photo of Prof. Chant by Kennedy.)

LARGEST telescope in Empire will bring the Heavens to Dunlap Observatory on North Yonge Street—Seen from Highway.

By KENNETH CRAGG.

Three rust-red, copper-sheathed domes, topping a stone building which stands on the highest level of a mound rising east of Yonge street and a short distance north of the Langstaff Jail Farm, give the highway motorist some conception of the wonder that is to be the David Dunlap Observatory, the latest major addition to the University of Toronto.

They give a conception only, for nothing but the foundation of the feature part of the observatory is visible at the present time. To the uninitiated, the concrete piers, in time to bear a telescope that is larger than any other with the exception of the giant instrument in the Mt. Wilson Observatory, California, might be anything from the base of a new-fangled bat cage to the beginnings of a Hydro sub-station.

Within a few days a little tramp steamer will dock at the foot of York street. Out of her hold will be lifted the most essential part of this observatory, the great 66-ton telescope, largest telescope in the British Empire and second largest in the world.

It will be transported by motor truck, along with the parts of the 180-ton dome structure, from the quay side to the Markham Township observatory site and will be mounted on the concrete base. Months later—some time next year—the two and one-quarter ton mirror with its 74-inch concave face will be bolted to the base of the telescope. The observatory will then be ready for use and a long dream of Professor Clarence A. Chant, eminent astrophysicist and head of the Department of Astronomy, University of Toronto, will be realized.

Perhaps not fully realized, for deep down in that savant's heart is a hope strongly rooted, that this observatory will make distinct contributions to science and if they are made during the period that it is under his skilled and devoted direction, all the better.

ready for use, some one will be on duty by the telescope every hour of a clear night. Every clear night the great shutters on the top of the dome will be opened wide and through the sixteen-foot opening, the skies will be raked by the telescope. Observations will be made and photographs will be taken.

The labors of the little group of scientists stationed there will not be halted by wintry cold if conditions for observations are favorable. It can be cold there—ask the workmen engaged on the Administration Building who were up on that mound, exposed to every wind that blows, during the past winter. On clear winter nights when the wind will howl around and through the dome, muffled figures, with electric heating elements in their special clothing, will stand watch in the eerie light as the Northern Lights sweep up in great tongues of palely tinted fire.

There is in this story of the fulfilment of the professor's dreams, the element that makes "human interest news." For the observatory is not only being erected in Dr. Chant's native township, but the place where this famous York County native son was born, some six-and-a-half miles away across country at Unionville, is visible from the roof of the Administration Building.

There are few stories of the star gazing of Clarence Chant as a youth. He had a close kinship with nature and the "forget-me-nots of the angels" which nightly hung over his head doubtlessly impressed him and sent him with good heart, up from Markham High School, through the University of Toronto and Harvard and later back to Toronto where he joined the University staff in 1891.

But beyond personal ambitions, there rests in the minds of Professor Chant and his colleague, Professor R. K. Young, the determination to direct the observatory in such a manner that it will be a worthy memorial to the man whose name it bears.

Keep Constant Watch.

Once the equipment is in its place and

That is how discoveries are made, sometimes by tracking through the countless miles of space to a definite objective and sometimes through countless camera shots with the camera lenses fixed in time exposures on the telescope's mirror.

Professor Chant states there is a practical reason for all of this vigilance. The equipment costs too much to let it remain idle one unnecessary hour. And besides, while a large amount of the department's teaching work will be lifted from the half-pint observatory, located in the angle formed by University College and Hart House, to the Dunlap Observatory, that latter institution's chief function is astronomical research and study.

The late David Dunlap would have it so. He was a keen student of the heavens and astronomy and geology were his favorite studies. Several years after his death in 1924 Mrs. Dunlap became interested in the project and years before the formal announcement of the project was made by Professor Chant in December, 1930, definite assurance had been given that the memorial would be erected by Mrs. Dunlap and her son, D. Moffatt Dunlap. In fact, the order for the telescope and its equipment was made in May, 1930, with the Sir Howard Grubb Parson and Co., Newcastle-on-Tyne, more than half a year prior to the announcement.

The location was fixed late in December 1930. For some time it was believed that the district around Richmond Hill [illegible] advantageous. In choosing that mound just south of the Hill and a quarter of a mile to the east of the highway, the [illegible] interested in the development believed they had found

an ideal spot. It was determined that the railway running midway between the observatory site and Yonge street, would [illegible] cause [illegible] vibration. It was ascertained that the observatory site, 75 feet above the highway level, was free of ground [illegible] and [illegible] of low hanging fog. Approximately 178 acres were secured for park land development, to give the institution an adequate setting.

Full appreciation of that setting is [illegible] unless a study is made of the [illegible] from the roof of the Administration Building. On all sides the ground [illegible] regular folds until it meets [illegible] and some near and one far [illegible] rolling valley [illegible] point.

Building Care Essential.

The circular concrete [illegible] surrounding the telescope foundation is exactly [illegible] feet above sea level, and the entire concrete work rests on solid strata 35 feet below the ground level. In the construction of the foundation and in the foundations of the Administration Building care such as is given seldom in any other type of structural work, kept the contractors longer than a layman would anticipate. The Administration Building excavations were started [illegible] August. The interior is not finished [illegible]

[illegible] difficulty was experienced [illegible] material over the temporary right of way from Yonge street. Trucks were bogged and untold hours of back-breaking labor were required to lift them up to the [illegible] [illegible] [illegible] construction [illegible] built in a [illegible] and the observatory [illegible] up in an afternoon.

The telescope is now on its way three years after the order was given. But the

mirror is not with it. The original plans [illegible] [illegible] best results could be obtained [illegible] made from a [illegible] [illegible] temperature than ordinary [illegible] the Toronto order was the largest [illegible] [illegible] [illegible] 19 inches [illegible] The [illegible] [illegible]

[illegible] Observatory at Victoria, B.C. when a [illegible] telescope was installed in 1918 [illegible] the [illegible] telescope in the world and is [illegible] only by the 100-inch telescope mounted at the Mt. Wilson Observatory.

Professor Young was appointed to the Victoria institution in 1918 and served there for five years. In 1924 he joined the University of Toronto staff and brought with him the rarely combined talents of instructor, research worker, astrophysicist, mechanical engineer and lathe worker. Prior to the present occasion when they have been given [illegible] improvements for the Dunlap telescope [illegible]

Telescope Is Gigantic

[illegible] development. A Titan was installed in

the basement of Baldwin House, St George and College streets, and after long weeks of labor, the telescope was completed. It had the distinction of having the largest pyrex mirror of any telescope up to that time and of being the second largest telescope in Canada.

This instrument, which will fall one point in comparative greatness when the new telescope is completed, is already established in the south dome of the new observatory, although it will not be ready for use until autumn.

When the Dunlap telescope is completely installed its makers claim that the surface of the moon can be made to appear no more than 50 miles from the eye pieces of the instrument. An object the size of Hart House, they say, would stand out clearly while the mountains and major deep pocked areas on the moon's surface would loom out in heavily defined lines.

While the mirror is, undoubtedly, the heart of the telescope, the mounting is of supreme importance. The ends of the main mounting, called the polar axis, rest in bearings that are fastened to the concrete piers already in place. Near the end of the polar axis that rests on the lower pier, a cross arm is fixed at right angles that is known as the declination axis. On one end of the declination axis is bolted the telescope and on the other end is bolted mechanism which also serves as a counter weight to offset the weight of the telescope.

The purpose of the mounting is not only to support the optical part but to enable the observer to train the telescope on any celestial object and to hold it in the field of view for examination or photography. This is a difficult matter for an astronomical telescope because the earth's rotation makes all celestial objects appear to rise in the east, pass across the sky and set in the west, and to follow them, it becomes necessary to move the telescope by clockwork or electric motor rotated to move the instrument at the proper pace.

The instruments are balanced so evenly on either polar or declination axes that a comparatively slight pressure will move them. By the employment of the two axes, at right angles to each other, the telescope can be pointed to any point in the sky.

Beyond the scope there appears to be little small talk between the reflecting electrical and type that is commonly known as the first case, the rays of light are received and focused by a concave mirror or system of mirror, and in the other, the light passes through a large lens. Telescopes of the first class are called "reflectors" and second, "refractors."

Face Is Renewable.

In the "reflector" type, light from a star passes down the open tube to the large concave mirror. It is reflected back from the silvered surface to a converging focus point at or near the forward end of the tube and is then intercepted by a small flat mirror placed a short distance inside the focus and diverted to the eye piece or camera placed there to receive it.

It is all a clear as that. The big mirror is swung to action. Its great concave face pushes on the feeble light rays of a distant astral body. The eye pieces are focused on the object and a new planet is discovered.

Even readers that that broadly defined picture gives an accurate conception of the operation of a telescope. But it does not take in anything of the innumerable pieces of apparatus that are used in the process. It does not even take in the electric motors that turn the dome around on its track so that the opening in the top can be placed in any quarter desired by the operator.

It hasn't a place for the electrically operated elevator that is used every time the mirror has its face washed. Silver tarnishes quickly and telescope mirrors must shine at their best at all times if discoveries are to be made. And it isn't like lifting down the bathroom mirror when this 5,000 pound looking glass is taken out of the base of the telescope. At the Dunlap Observatory it will be raised out of the base by the elevator. The old silver on its face will be removed and a new coating applied, right on the premise.

More of the right on the premises work will be undertaken in the near future when officials will start making photographing tele scopes out of lenses and odds and ends, for use in the north dome on the Administration Building. So far, nothing but plans are in prospect for the centre dome. Some day, they hope to have a 10-inch lens telescope installed there.

At present there are no immediate prospects for the completion of that plan, but time and the collection of odd bits of glass and metal tubing can do wonder. The equipment of the Department of Astronomy, University of Toronto Friends in the department can't forget that 19-inch telescope in the south dome.

201 Madison Ave
June 26th 1933.

Dear Mr Dunlap:

I'm not sure know
that you're coming this Sat + Mrs Dunlap
and I am - and that [illegible]
with us, it will be a great disappointing
evening seeing the wonders of Donalda
Farms. It was an inspiration of some
kind striking the idea and then
Lake Park Lewis as they did it

Note from C.A.C.

I went up to the Observatory Monday and according to arrangement Mr. Holden came up to pick me up and take me home. He was rather late on account of the thunderstorm and did not arrive until 5.45. He had with him his brother and Phyllis and Tom. We looked around a little and he was favorably impressed with everything.

On the way home we discussed the water supply and also the entrance to the grounds. I told him I thought the superintendent Le Pan had pretty fully investigated the former. He agreed and said he would instruct Le P. to proceed with the project.

As to the road, he expressed willingness to give a 99-foot roadway through his property and he wished me to get the superintendent's office and Mr. Young (in my absence) to splen-

The Great Pier
June 19, 1933 (Leica Camera)

NATURE July 22, 1933

Annual Meeting of the Royal Society of Canada

THE Royal Society of Canada held its annual meeting on May 18-20, at Queen's University, Kingston.

In his presidential address to Section 3 (Mathematical, Chemical and Physical Sciences), Prof. C. A. Chant dealt with the inception and constructional progress of the new 74-in. telescope at the University of Toronto. After paying tribute to the generosity of the donor, Mrs. David Dunlop,

Prof. Chant told how the project is being carried out. The administration building is nearly completed and the great dome will be erected during the summer. The mirror is to be made of pyrex glass of especially low expansion coefficient, which is expected to be of great advantage. Delivery for grinding is promised by the makers in September.

July 11, 1933.

NEW OBSERVATORY IS BEING BROUGHT CLOSER TO COMPLETION

Most modernly equipped and to house one of the world's largest telescopes, the David Dunlap Observatory, situated at an elevation of 750 feet about half a mile southeast of Richmond Hill, is nearing the final stages of construction. Above are pictured, at left, the massive cement base on which the big telescope will be erected, and, at right, the administration building, with its three domes brought across the Atlantic for installation. The observatory is a gift to the University of Toronto by Mrs. D. A. Dunlap in memory of her husband.

The Globe. July 25, 1933

TORONTO, WEDNESDAY, AUGUST 2, 1933.

SHIPMENT OF STEEL FOR DUNLAP OBSERVATORY ARRIVES IN CITY

The Globe
Aug 2, 1933

A rather strange-looking collection of structural steel pieces did on the docks at the Toronto Terminal Warehouse, long curved pieces, shorter curved pieces, straight sections tapered beams even a set of latticed steel stairs, the weight of the whole unique consignment being estimated at well over 200 tons. All pieces are marked "Made in England," and addressed to the Dunlap Observatory, Richmond Hill, and the arrival of this shipment means active construction work on the giant telescope and observatory which is being given to the University of Toronto by Mrs. D. A. Dunlap. Illustration, above by The Globe photographer show scenes on the dock as a derrick, aided by a crew of husky workmen and numerous trucks, started the job of transporting the steel. One of the many curved pieces being placed on a truck is seen at the upper left; the right-hand picture shows workmen handling another of the lengthy beams; while below is a general scene of the dock, giving an idea of the size of the consignment being gathered from the fact that everything visible in the photograph except the derrick is part and parcel of the shipment. Giant telescopes are intricate things.

Photograph taken at Toronto Waterfront

Photographs by University Photographer

The flat boxes contain the Sheet Metal for covering the wall of the building and the "Agasote" for covering the revolving dome. About Aug. 2, 1933

Material for the Great Dome, on the dock at Toronto. About, Aug. 2, 1933

Views of the Erection of the Circular Building and Revolving Dome. Aug. 8 and 16, 1933

Looking N.E. Aug. 8

Looking N.W. Aug. 8

Looking N.W. (from second) story in Administration Building. Aug. 8

Looking North. Aug. 8

Travelling Crane. Aug. 8

The wall erected, the base of the dome (on wheels) in place ready to receive the framework. Aug. 16, 1933

The first curved member of the dome being lifted to its place. Aug. 16, 1933

Photographs, August 16, 21, 25, 1933

Portion of shutter in centre.
Aug. 16

Aug. 16

Sinking test hole for Water.
(100 ft. E. of Administration
Building went down 242 ft. un-
successful. Aug. 16

Aug. 21

Aug. 25.

F. J. Bell, C. A. Chant. Aug. 25.

F. J. Bell, H. P. Martin, Aug. 25, 1933

University of Toronto
TORONTO 5, CANADA

DEPARTMENT OF ASTRONOMY

Go Home Bay,
August 6, 1933

Dear Mrs. Dunlap,—

After a long wait I got the enlargements from my little negatives, and they are not quite so good as I thought they were. I enclose five of them and will show you the rest later.

I wrote Mr. Holden quite a long letter last week, and probably he has taken up with you some of the matters I discussed. They referred chiefly to the entrance from the south and the furnishings of the Administration Buildings. Maxwell and Shortredé of the Superintendents Office, and Young and I examined sketches of alternative routes and discussed them on the ground. We were unanimous in our conclusion that a road truly N.-S. from the centre of the great dome, and parallel to the front of the Administration Building was the best. Young and I had rather favored swerving to the east near the old pump and then

[illegible] reach
St., than
northward
inistration
it would
ed he
me would
long.
return on
retary on
progress
, although
I suppose

and go
s pro-
owing
Nearly
ully

he build-
sition
here are

Thurs-
hey
hope

ng from the Dominion
ope. To put into position
is about 14 tons, with its
wo cranes, i.e., the one
will lift it far up in
utter opening in the
was proposed to leave out
be brought within; but
an sent out from New-
method. I believe the
was expected, and hope

gs for the dome, Sullivan
on the smaller domes, wish
other tenders also.

the entrance has been sent
. I wished to have some of
believe they did not have
rly. You will probably get
can get the sidecod
by which the municipality,

two floors of the dome and
if the telescope for the
Dr. Young's reflector
pleted. The latest news
he mould about the middle

yours

201 Madison Ave.,
August 20, 1933

Dear Mrs. Dunlap,—

Enclosed herewith is a copy of a letter to Mr. Holden, in which some account of the work on the Observatory is given. As you are quite as much interested I typed it so that you could have a copy.

Matters are proceeding rapidly and I shall be "on the job" all the time.

Also enclosed are some more enlargements from the Corning film. I had these made through J. F. Hardy Co., the agents for the Leica camera, and I think they are rather better than the previous ones. When I get out to see you we can discuss them together. I send also a print from a negative taken on Wednesday last.

I hope you are quite well; I know you are busy.

Very sincerely yours
C. A. Chant

P.S. I have had my first lesson in driving a car.

To keep you informed
C.A.C.

August 28, 1933

Dear Mr. Holden,

The work on the big dome is proceeding rapidly and satisfactorily. Practically all the heavier structural part is done with the exception of the shutters. A multitude of bolts have yet to be put in, especially in the metal covering of the walls. The building looks fine. The gallery around it and the windows with their shutters add variety to the picture.

The Dominion Bridge Co. have sent in a tender for the erection of the telescope, which is now timed to arrive about the last week of September. They offer to do the work at cost plus 10 per cent., with a guarantee not to exceed $2000. Mr. Bonus told the firm that this limit seemed rather high. They replied that the work is of such a special nature and the instrument is of such great value that they felt they should have that amount, but they said we should be charged according to cost. The firm had proposed to erect a second derrick like the "stiff-leg" one now in use, and to employ the two at the same time to handle the polar axis, which, I learn, with attachments will weigh 16-1/2 tons; but now they intend to instal a derrick with an arm 92 foot long and able to carry the entire weight. They own the derrick. The erection of it, or of a second smaller one, is a considerable part of the cost. The big one is to be mounted on the ground, not on a platform, as is the one now in use. The formal tender will go forward to you at once. The Superintendent's Office and I think it wise to accept it. Mr. Bonus says the firm is worthy of trust, and that from a progress report on the big dome the cost of erecting it will be well within the limit set.

Sullivan and Fried have not yet sent an estimate on the covering of the big dome. There is still some consideration of the best way to fasten on the inner coat of agasote, but the estimate should be ready in a few days. The dome should be covered before the telescope is put in place.

The digging of the well is giving some anxiety. At a depth of about 15 feet boulder clay was struck, and it lasted until about 342 feet when shale was reached. After a few feet in this the digger, Mr. Davis, said he thought it unwise to go farther. He said that water obtained in a stratum of shale was nearly always salty and unusable. Professor Coleman could not be reached but his successor, W. A. Moore, was in town. He was taken up on Friday. He examined the samples brought up from different depths, and agreed with Davis that it would be useless to go deeper. Davis was instructed to pull up the 170 feet of casing which he had put down.

The question then was where next to sink a test hole. Davis suggested between the railway and the creek on Stephens's property, but was told that was out of the range of possibility. Exploration east near Bayview did not seem promising. It would seem that all the wells which were on the Observatory property, as well as those at the houses just north of us, are shallow and receive only the water which filters through the layer above the boulder clay. The boggy land on Bayview probably gets its water in the same way. There is little there now.

the creek flowing through
into a much larger current
a considerable depth with
t the best place to try
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ck. Davis agreed that this
try there is being sent
n touch with your Mr.
r is being sent as usual.
you. I do hope we shall
nce to pump will be much

VanNostrand's men were

y yours

C.A.Chant

University of Toronto
TORONTO 5
DEPARTMENT OF ASTRONOMY

TORONTO ONTARIO
AUG 30
1933
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CANADA
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Mrs. D. A. Dunlap,
Don-Alda Farm,
Todmorden P.O.,
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THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

Vol. XXVII, No. 7 SEPTEMBER, 1933 Whole No. 220

PLATE VI

THE DAVID DUNLAP OBSERVATORY

Top—The Administration Building.
Below—The tube for the great telescope on the foundation of the tower.

Issued by the Royal Astronomical Society of Canada, 1933

PROGRESS ON THE DAVID DUNLAP OBSERVATORY

By C. A. Chant
(Director of the Observatory)

THE Administration Building of the Observatory is practically finished. The lighting fixtures have yet to be put in and the electric service wires have to be brought to the building. During construction wires were carried on temporary poles so that power could be available for the various sub-contractors. Ultimately on the observatory property all the wires will be placed underground so that no disfiguring poles will be seen. During the summer many visitors driving along the great highway to the north have come up the half-mile roadway, although it has been in poor condition through the heavy trucking over it. An entirely new entrance to the grounds is to be built from the south. There has been general comment on the artistic design of the exterior of the building and on the beautiful and substantial manner in which the interior is finished. The furnishing of the building will be undertaken soon. A view of the west front of the building is shown in Plate VI.

The 74-inch reflector constructed by Professor R. K. Young and described in this JOURNAL, January, 1930, is in the south dome but is not yet mounted. The last task performed by the contractors' steam hoist before it was dismantled was to raise this telescope to the roof. It is expected to be in use in the autumn. The reflector for the central dome and the photographic outfit for the north dome will be provided later.

The cement foundation for the 61-foot circular building which will house the 74-inch reflector, and also the massive pier for the instrument itself, have been ready for some weeks. A view of these as seen from an upper story north window of the Administration Building is shown in Plate VI. The strange-looking pier has elicited many odd conjectures and remarks from the visitors.

The steel building, with its revolving dome, was constructed in England and was shipped by steamer directly to Toronto where it arrived on July 29. It is now being erected by a local contractor.

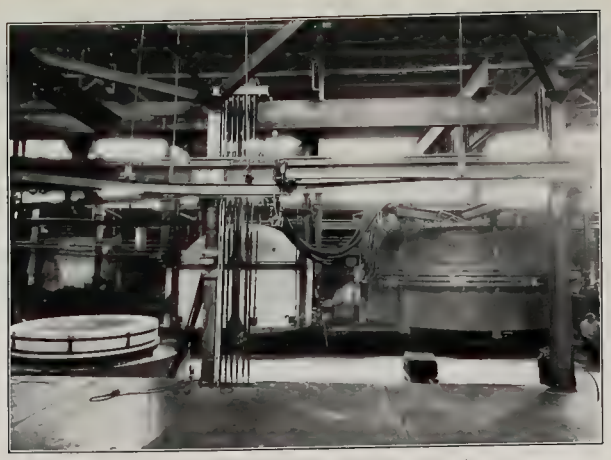
The great telescope (except the mirror) will arrive in Toronto about September 1 and will be erected at once. A representative of the firm of Sir Howard Grubb, Parsons and Co., which is supplying both telescope and building, will be on hand to supervise their erection.

Some delay has been experienced in obtaining the mirror. Extensive experimenting was carried out by the Parsons Optical Glass Co. in preparation for casting the big disc of glass, but after three years these efforts were abandoned, and a large English plate-glass firm offered to undertake the work. In the meantime, however, the labour on the production of a 200-inch quartz disc for the California Institute of Technology had been discontinued and the Corning Glass Works had begun the casting of large discs from their well-known Pyrex glass. A 30-inch and a 60-inch disc had been successfully made, and the company was ready to proceed with larger sizes. Now ordinary Pyrex glass has a much smaller coefficient of expansion than that of crown glass, the ratio being about 32 to 72, and hence it is much more desirable for a telescope mirror. The English contractors on learning of the successful production of these discs hesitated to proceed with a crown glass disc, although it could be obtained much more cheaply. They were anxious to supply a telescope of the very highest quality, and after some negotiations they gave the Corning Glass Works an order for a Pyrex disc. Still further research by this company enabled them to offer a material having a coefficient of expansion one-fourth less than that of ordinary Pyrex.

The disc was poured at Corning, N.Y., on June 21. At the invitation of the firm a party went by motor from Toronto to Corning (some 240 miles) to witness the operation. Those present were Mrs. D. V. Dunlap, the donor of the Observatory, Mr. C. A. Chant, Professor R. K. Young, Mr. P. H. Mitchell, consulting engineer, Mr. E. Jno. Ball, the agent in Canada for the Grubb-Parsons firm, and the present writer.

I believe that usually in casting a large disc like this the glass and other ingredients are melted together in a furnace which is then tapped, and the liquid glass flows out into the mould. That method

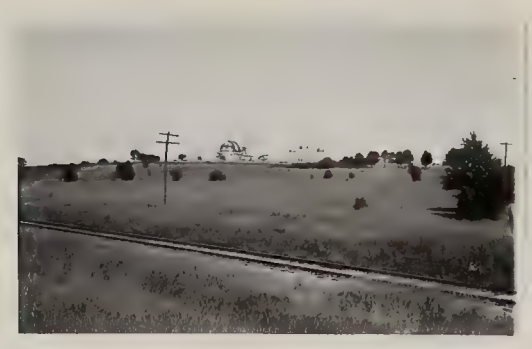
[illegible]



284 *Progress on the David Dunlap Observatory*

m England. When finished the disc will have a diameter of 76 inches, a thickness of 12 inches at the edge and 11 at the centre.

I hesitate to predict when the mirror will be ready, but hope that there will be no unforeseen causes for delay and that it will be ready to be put in its mounting in one year.

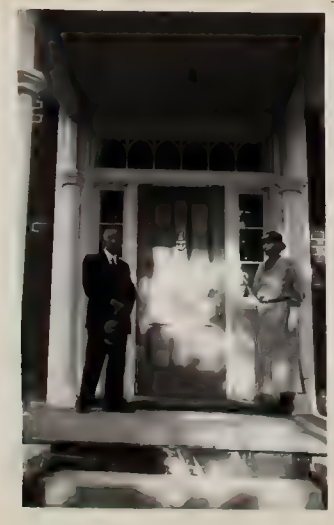


Aug. 30, 1933

Dr. L. S. Bell, Winnipeg, Mrs. Dunlap, Miss Cassie Bell, New York, Mrs. R. W. Hopper, R. W. Hopper.

Mrs. Dunlap, Dr. L. S. Bell, C. A. C., Miss Cassie Bell.

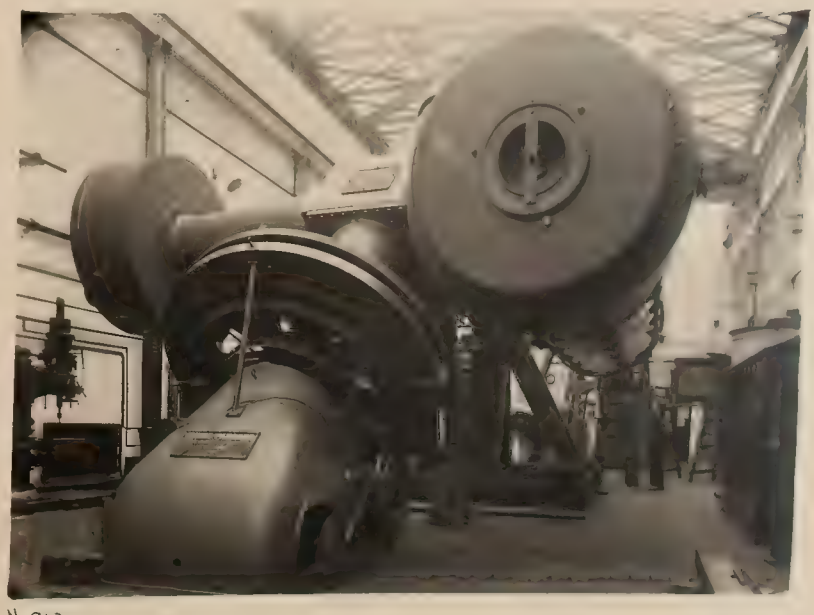
R. W. Hopper, Dr. L. S. Bell, Miss Cassie Bell, Mrs. Dunlap.



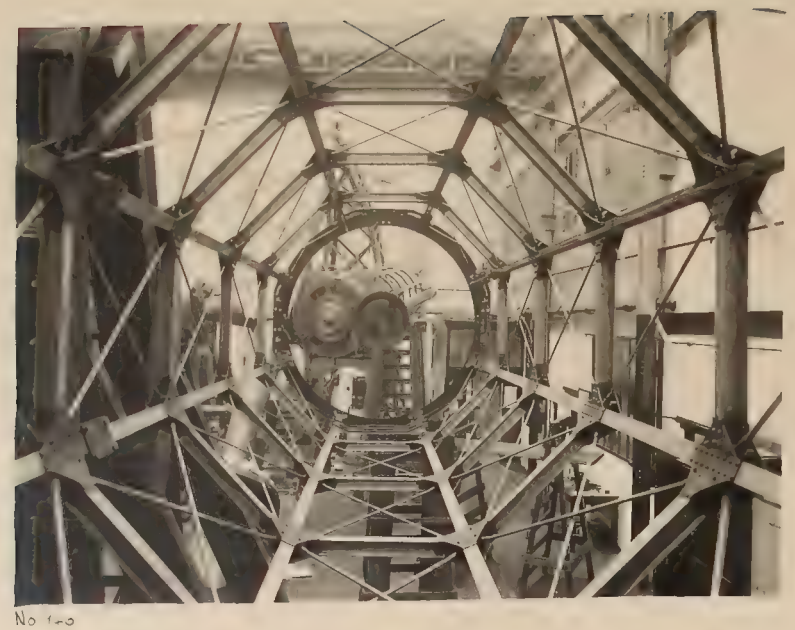
C. A. C., Mrs. Dunlap

Photographs at Observatory House
Sept. 3, 1933

View of Telescope in Shops – Looking N.W. July 1933

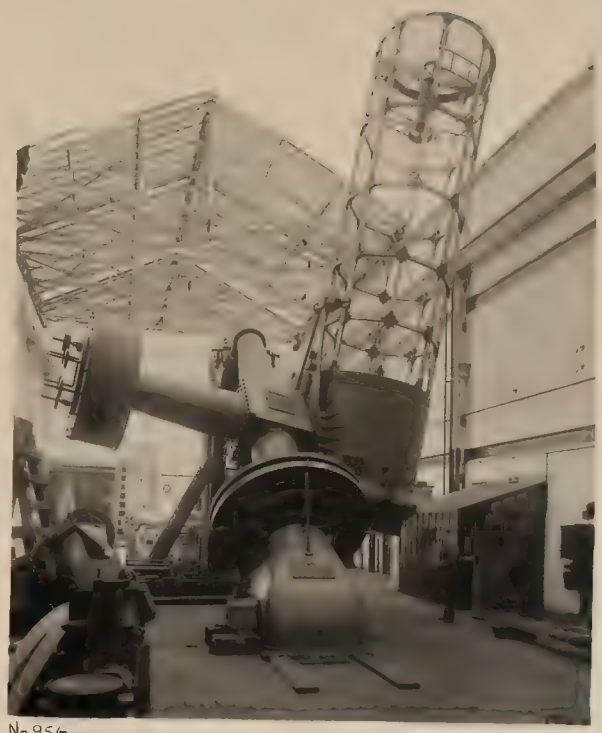


The completed Telescope – Tube horizontal, pointing North – July 1933.



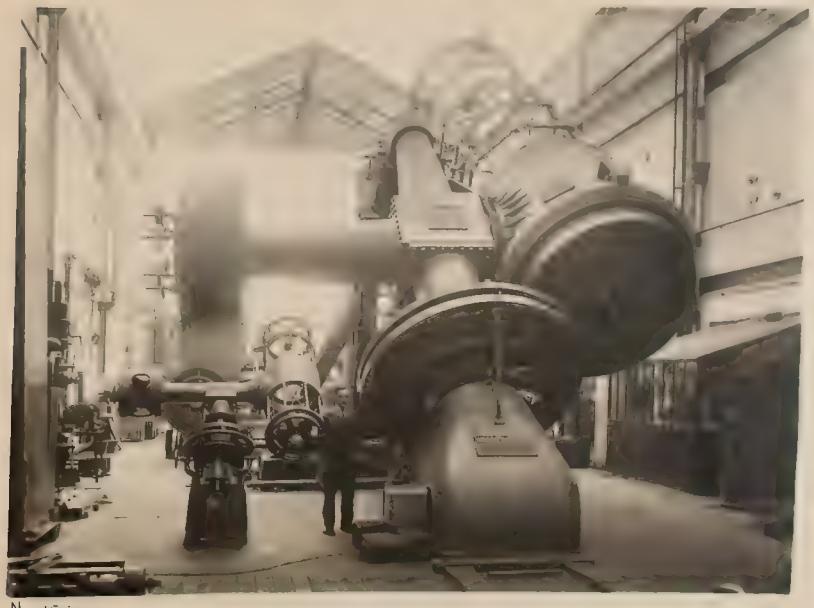
View of interior of the tube, from inside the centrepiece – in the distance is the 36-inch telescope for Greenwich. July 1933

View of the Telescope, Looking N.W. – The tube is on the east side of the polar axis and is nearly vertical. Aug. 1933



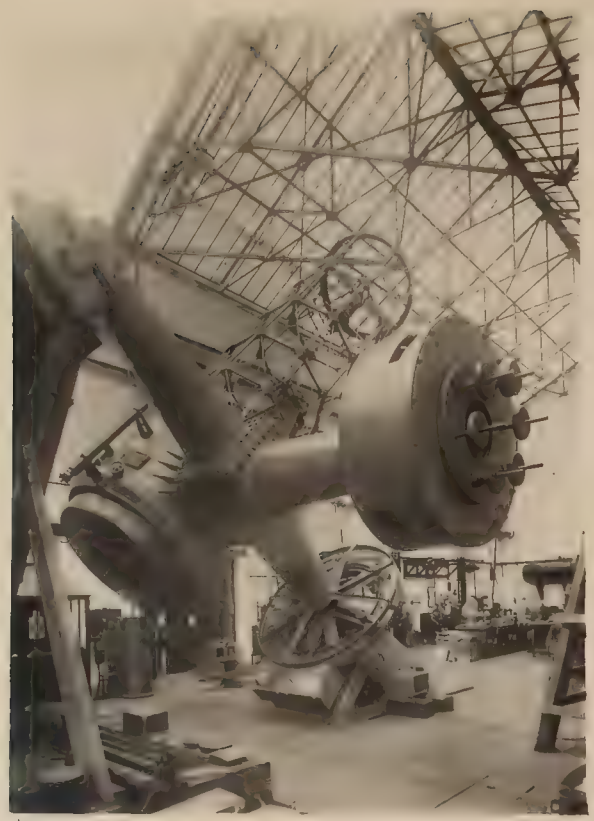
No 956.

View of Telescope, looking nearly North - The tube is on the east side of the polar axis which is turned slightly to the east. August 1933



No 45.

The 74-inch Telescope and the 18-inch reflector for Dundee - Both are pointed approximately towards the pole of the sky August - 1933



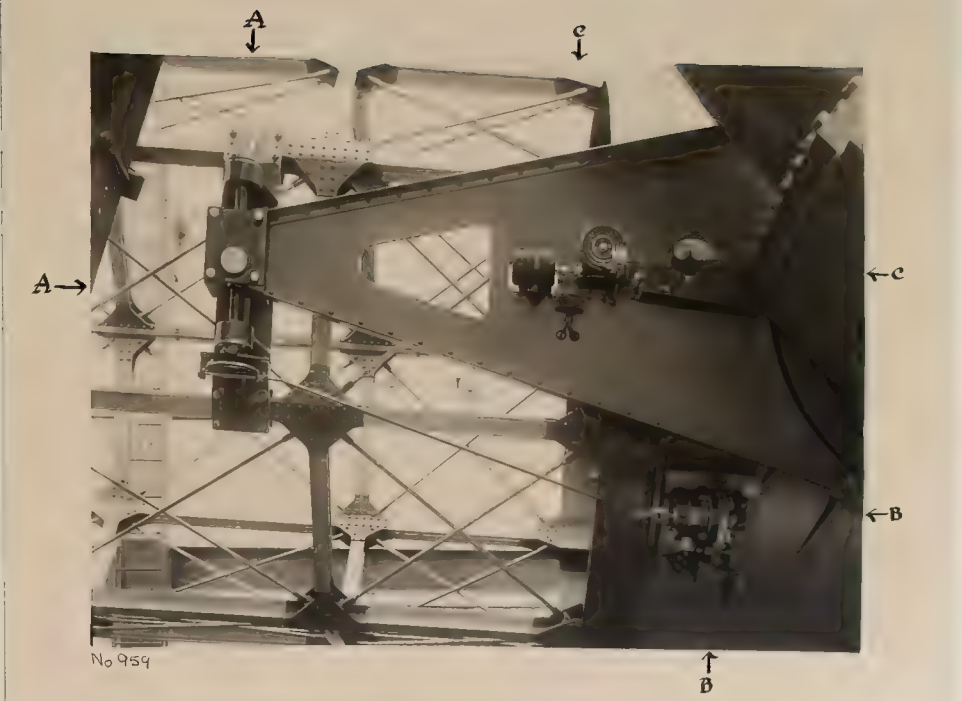
No 455

View of the Telescope, looking south-east.

The tube is on the east side of the polar axis and pointing approximately towards the celestial equator. August 1933

No 458

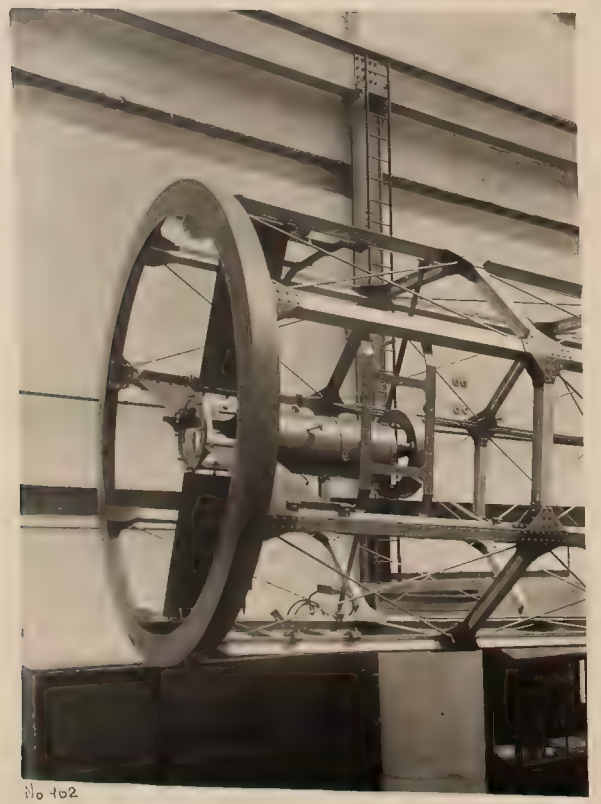
The driving Clock of the Telescope. August 1933



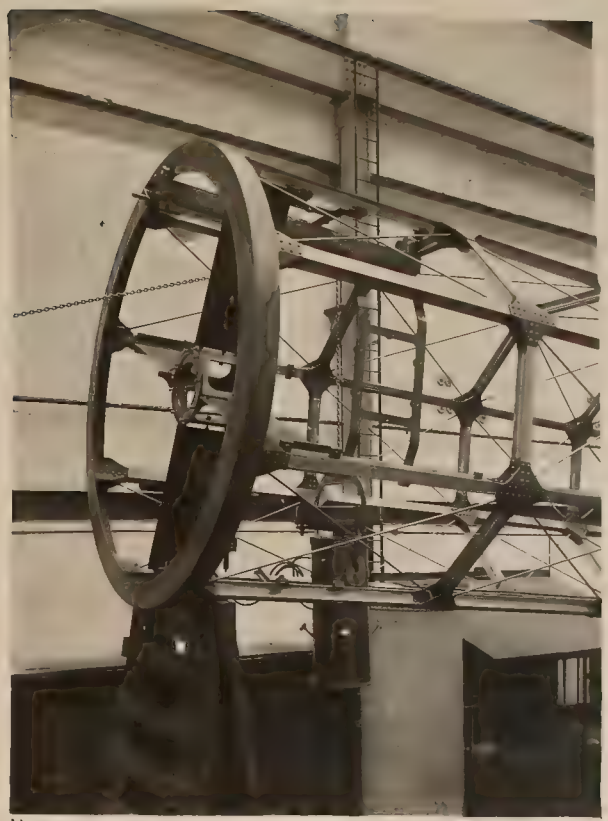
Close-up view of the Declination Clamp (A,A) actuated by the motor (B,B), also Gear for slow motion (C.C). Aug. 1933

View of the iris Diaphragm, taken from inside the tube. Diaphragm nearly closed Aug. 1933

View looking down the tube from outside it. Aug. 1933



The holder of the Cassegrain Mirror, and gear for focussing it, in place at upper end of the tube. Aug. 1933



No. 963.

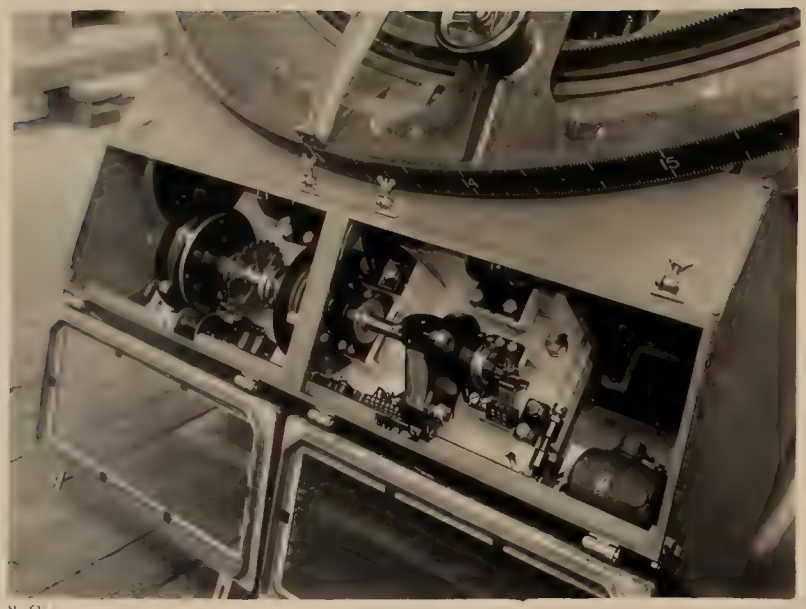
Cassegrain holder and focussing gear being removed from the top of the tube. Aug. 1933

No 964

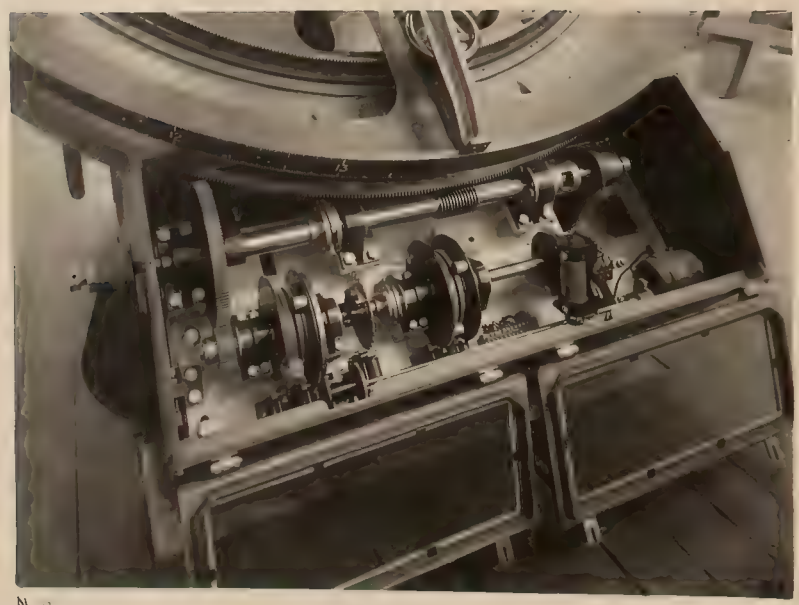
Holder of Newtonian (flat) mirror in place at the top of the tube. Aug. 1933

No 965

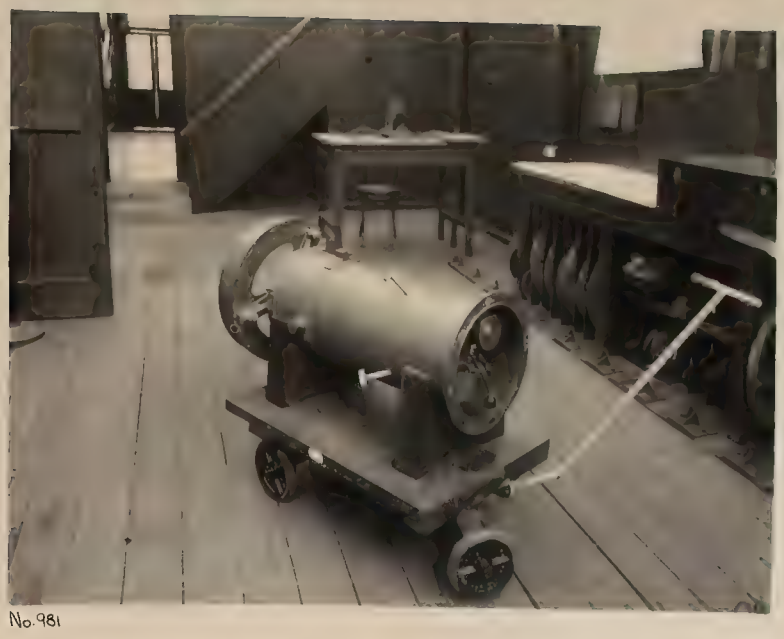
Newtonian holder being removed from the top of the tube. Aug. 1933



Gear Plate of the Great Telescope, View from Right. August, 1933

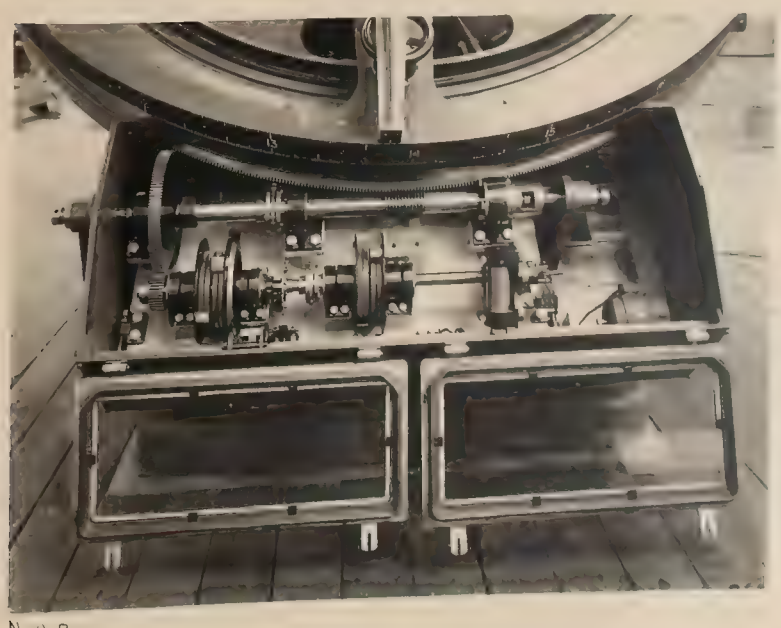


Gear plate, View from Left. note the driving worm and the great worm wheel or driving circle (see pages ...24.....) Aug. 1933



No. 981

The holder of the Cassegrain Mirror, with its Focussing Gear (within the tube) When not on the Telescope, it is kept on its truck (see pages 110, 111) Aug. 1933



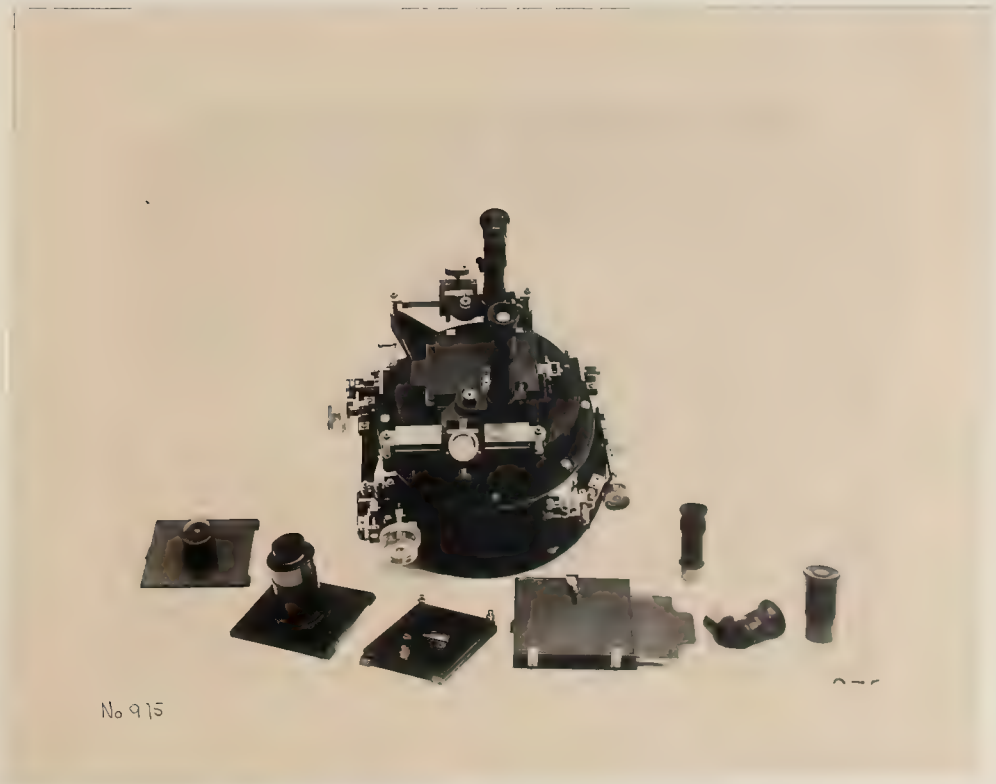
No 408

Gear plate, Front View. Aug. 1933

Newtonian Breechpiece, with large Plate Holder. Aug. 1933

Newtonian Breechpiece, with small Plate Holder and Guider Eyepiece. The breechpiece is atached to the telescope tube near its upper end. It is used when direct phographs of a celestial object are being taken. Aug. 1933

Newtonian Breechpiece, with small Plate Holder and Guider Eyepiece. The finder Telescope is in the foreground. Aug. 1933



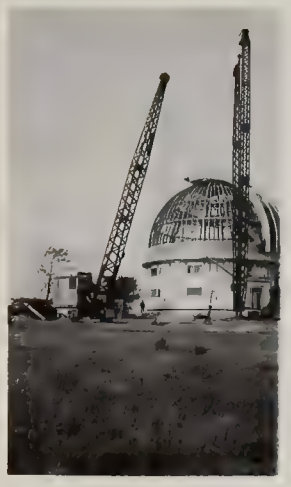
Newtonian Breechpiece, with all Plate Holders, Eyepieces and other atachments. Aug. 1933

Photographs taken September 7, 1933

Taken from the parapet of the Administration Building

The above Photographs show the second Shutter being lifted into place.
This was the last work for the hoist shown in the pictures and it was dismantled a few days later. September 7, 1933

Work proceeding on the shutters. The old crane still in place. Sept. 12, 1933



The new 20-ton crane (at right) and the caterpillar crane. October 3

The Administration Building. Oct. 3

Showing progress in covering the dome with "Aqasote" Oct. 3

Looking almost North. Oct. 7, 1933

Looking almost West. Oct. 7, 1933

These two views show progress in covering the dome.

From "Nature", London Eng.

The 74-inch Reflecting Telescope for the University of Toronto

SINCE November 1930, a 74-in. reflecting telescope—the largest in the British Empire and the second largest in the world—has been under construction for the University of Toronto at the works of Sir Howard Grubb, Parsons and Co., Newcastle-upon-Tyne, a subsidiary company of Messrs. C. A. Parsons and Co., Ltd. The observatory will be situated in a park of 177 acres on Richmond Hill, eight hundred feet above sea-level, a few miles to the north of Toronto and, in addition to the 74-in. reflector and its dome, will comprise a block of administration buildings on which three smaller domes will be mounted. It is being built as a memorial to the late David A. Dunlap, the funds being provided by his widow and son, and, on completion will be presented to the University of Toronto and administered by the Department of Astronomy.

The telescope is of the reflecting type with a clear aperture of 74 in. and is arranged so that it can be used either as a Cassegrain or Newtonian (Fig. 1). The mounting is of the modified 'English' or 'Compensated' type in which the tube is placed on one side of the polar axis and the counterpoise on the opposite side.

The Mounting

The polar axis is 22 ft. long, built up of two tapered tubular steel castings with forged steel pivots shrunk into the ends and bolted to a central cubical steel box. It runs in self-aligning radial ball bearings with ball thrust bearing at the lower end housed in a cast iron base casting. The weight of the axis is nine tons. The bearing housing at the upper or North, end is fitted with adjustments for the true alignment of the axis.

The driving circle, or wormwheel, is mounted free on ball bearings on the lower pivot of the axis and can be clamped rigidly to the quick motion gear wheel, which is keyed to the axis, by a motor operated clamping gear. The circle is a steel casting and the bronze rim, in which the teeth are cut, is slightly shrunk on and fixed with a number of delta metal screws. The pitch diameter is 8 ft., cut into 960 teeth of 8 mm. circular pitch. The wheel was copied from a 4 ft. diameter master circle graduated on silver.

The sidereal circle is 8 ft. diameter and is strung on the boss of the driving circle. It can easily be rotated by any one of six handwheels attached to it and fitted with pinions gearing into a toothed ring attached to the driving circle. It is constructed of fabricated steel with a delta metal rim 3 in. wide graduated on both edges to 1 minute of time divisions. The lower set of divisions read against indexes fixed to the guard of the driving circle and mark sidereal time, while the upper set of divisions read against indexes attached to the polar axis and mark right ascension.

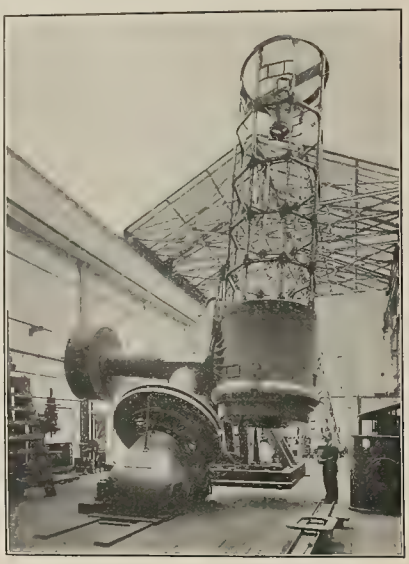


FIG. 1. The Toronto 74-in. reflector. View from south-east.

An hour angle circle is fixed to the quick motion gear wheel. The declination axis passes through the cubical centre section of the polar axis at right angles, supported at the outer end in a tubular tapered steel casting attached to the cubical portion of the polar axis.

The declination axis itself is of forged steel 13 ft. long, weighing 3½ tons and formed with a flange at the inner end 3 ft. 5 in. diameter, to which the tube is attached. It is mounted in ball radial bearings, with a double thrust bearing at the small, or outer, end, to which is keyed the quick motion gear wheel and also the declination circle 6 ft. 3 in. diameter, graduated to 1′ of arc. The gear wheel and circle are housed inside a drum-shaped casting attached to the end of the tubular support carrying the axis, this casting forming the counterpoise for the tube. The declination circle drives two drums 12 in. diameter, geared up 72 : 1, and arranged so that there is no backlash. These drums are graduated to 60 divisions, each division indicating 5 minutes of arc. The tube comprises three sections,

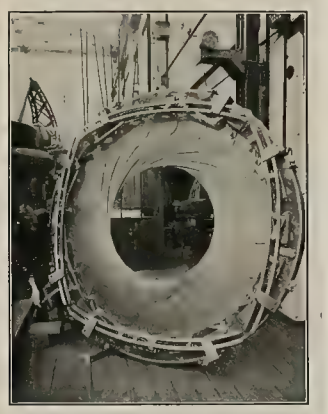


FIG. 2. The iris diaphragm. Half-aperture.

the lower portion a cell in which the main mirror is mounted, the central section which is bolted to the flange of the declination axis, and the upper, or skeleton, section for carrying the Cassegrain or Newtonian mirrors and the photographic breech-piece.

The main mirror cell is a ribbed steel casting fitted with nine circular pads for the back support of the mirror. The pads are mounted in groups of three on spherical seatings on three triangles, which are themselves mounted on ball-ended screws, by which the mirror can be 'squared'. The nine pads are so disposed that each bears its proper proportion of the load.

For the lateral support of the mirror, 18 weighted levers are disposed round the inside of the cell mounted on universal joints, the short end of the levers engaging in holes in brackets riveted to a flexible band loosely clamped round the mirror.

Description of the Telescope supplied by the makers.

This band has blocks fixed at intervals on its inner edge, loosely fitting into a groove in the edge of the mirror to keep it central. A large wormwheel is fitted to the back of the cell for carrying the spectrograph.

The centre section of the tube is a steel casting 7 ft. diameter weighing 5½ tons, and formed with a large boss on one side for attachment to the flange of the declination axis. Just above the lower flange, to which the cell is attached, the casting is swelled out to 8 ft. 7 in. diameter to accommodate an iris diaphragm (Fig. 2).

The construction of this diaphragm is generally similar to those used in cameras, but in order to prevent sag, due to the considerable weight of the leaves, and to keep the aperture central when the tube is in the horizontal position, it has been found necessary to guide the moving ends of the leaves between radius bars. The range of the diaphragm is from 12 to 74 inches aperture and is operated by a handwheel.

The upper, or skeleton, portion of the tube is octagonal in section, the main and cross members of which are constructed of 3-in. duralumin I beams, connected by steel gussett plates. Diagonal tension rods of duralumin, screwed with right and left hand threads, are fitted in each bay and tightened up to a predetermined tension, so that they are always in tension, whatever the position of the tube.

A fabricated steel box of square section, with circular flanges, is suspended in the centre of the upper end of the tube on four spring steel strips placed edgeways, to which the mountings for either the Cassegrain or Newtonian mirrors can be attached. Gear is supplied for handling these mountings and interchanging them conveniently and safely. The Newtonian mirror is arranged so that the reflected beam can be directed to any one of four positions round the sides of the tube, where frames are fixed to which the photographic breech-piece can be attached. This breech-piece comprises a focusing gear and plate holder with two guiding microscopes mounted on cross slides operated by micrometer screws. It is fitted also with a rotary motion to correct for rotation of the field. The plate holders take plates 3¼ in. × 4¼ in. and are interchangeable with a knife-edge focusing plate and with adapters for oculars.

The driving clock comprises a heavy crossed arm governor driven indirectly by a ½ horse power direct-current motor through a differential gear box. A weight suspended from a chain passing over a pulley and attached to the outside of the differential gear box gives a constant driving force to the governor. The gear box carries an arm with a contact at its outer end passing over a number of studs arranged concentrically and connected to resistances in the field circuit of the motor. When the motor is running at a correct speed, the weight is kept floating, but if its speed alters, the gear box rotates together with the contact arm, which immediately corrects the speed of the motor by altering the field resistance. The governor runs at 80 r.p.m. and is directly coupled to a worm gearing into a wormwheel on a jack shaft making one revolution in 24 seconds. The jack shaft is mounted parallel to the shaft on which the driving worm is cut and geared to it by a pair of accurately cut spur gears. Thus there are only one pair of spur gears and one worm wheel between the clock governor and the driving screw.

A 'Grubb' type of electrical control operated by one of the observatory clocks, is incorporated on the jack shaft.

The right ascension and declination quick motions are operated by 1½ and ¾ horse-power reversible motors respectively and are arranged to rotate the axes at the rate of one revolution in eight minutes. The drives are taken through dog clutches operated by solenoids in parallel with the motor circuits, so that the motors and reduction gears are automatically disconnected from the telescope when not in use. A friction clutch is also incorporated and the switch gear controlling the motors so arranged that when the motors are switched off the dog clutches remain engaged for a few seconds, allowing the friction clutches to slip and bring the telescope to rest.

The declination clamp is placed between the tube and the polar axis, and consists of a fabricated steel arm about 7 ft. long mounted on a 'V' ring 4-ft. diameter attached to the side of the polar axis. This arm can be rigidly clamped to the 'V' ring by a toggle gear operated by a small electric motor. The outer end of the arm carries a nut mounted on a link motion and engages with a screw mounted in bearings attached to a bracket which is firmly clamped to the side of the tube. A motor operated two speed gear is connected to this screw for giving the setting and guiding motion in declination. This motor is controlled by two separate reversing switches. For the setting motion a dog clutch operated by a solenoid in parallel with the motor connects the gear to the slow motion screw and moves the tube in declination through 15 minutes of arc in one minute of time. For the guiding motion an electromagnet in parallel with the motor brings a differential gear into action, giving a rate of motion of 30 seconds of arc in one minute of time. Similar rates of motion are provided for setting and guiding in right ascension.

Three finders are provided, one of 4½ in. aperture with eyepiece mounted on cross slides, at the lower end of the tube, one of 2¾ in., and one of 2 in. aperture at the upper end.

Optical Parts

The main parabolic mirror, of pyrex glass, will have a focal length of 30 ft. The Cassegrain and Newtonian mirrors, of hard crown, are of 19 and 20 in. diameter respectively, the former being designed to give an equivalent focal length of 111 ft. ($F/18$).

The total weight of the telescope is about 50 tons.

The stellar spectrograph is being constructed by Messrs. Adam Hilger, Ltd. It is of the single prism type with 2½ in. collimator and two cameras of 12½ in. and 25 in. focus respectively.

The Dome

The steel dome is 61 ft. outside diameter, with parallel opening 15 ft. wide extending from the horizontal to 7 ft. beyond the zenith. Two parallel moving shutters running on rails at the top and bottom of the dome close the opening and are operated simultaneously by means of wire ropes connected to a motor operated gear. An emergency hand gear is also provided. Two motor operated wind screens of sail cloth are mounted in the opening, one rising from the bottom, the other descending from the top.

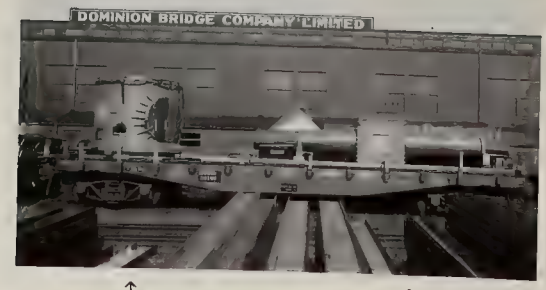
The dome, which weighs about 80 tons, is carried on 24 canted rollers of 27 in. diameter mounted in self-aligning ball bearings and running on a flat bottomed rail. Sixteen pairs of lateral roller bearings on the inner and outer edge of the rail keep the dome in position. Two segmental platforms, the lower one at the base of the opening, the upper one at the back at a 16-ft. higher level, are fixed inside the dome. Rails are mounted on the parallel straight edges of these platforms on which runs a bridge in the form of a semi-arc. This bridge is 5 ft. 6 in. wide, and divided into two portions, the right hand side forming a stairway, the left being a track on which a truck carrying the Newtonian observing platform runs. The upper portion of the truck is automatically kept horizontal as it travels up the curve of the arch, by means of a lever, the outer end of which travels on a contoured rail. The truck is operated by means of a motor driven winding drum fixed at the top of the bridge, where is also fixed the gear for giving it the cross traverse motion. The rail on which the dome runs is mounted on a strong annular girder on the top of 24 steel pillars, 21 ft. high. The pillars form a circular building, sheathed inside and out with steel sheeting.

The entrance is in the south side through a steel porch with two pairs of doors. The observing floor is 13 ft. above ground level with doorway leading on to the top of the porch. From each side of the porch a stairway gives access to a gallery running right round the building 23 ft. above the ground. A similar gallery on the inside of the building gives access to the lower segmental platform in the dome and so on to the Newtonian observing platform.

A lift is provided inside the circular building for removing the cell and its mirror when it requires to be resilvered. The 7½ horse-power motor and gear for rotating the dome will be fixed at ground level in the building.

Rotation is effected by means of an endless steel rope passing almost round an annular channel ring carried on brackets fixed to the base of the dome over two tangent pulleys and down to the turning gear, a tension pulley being provided for keeping the rope tight.

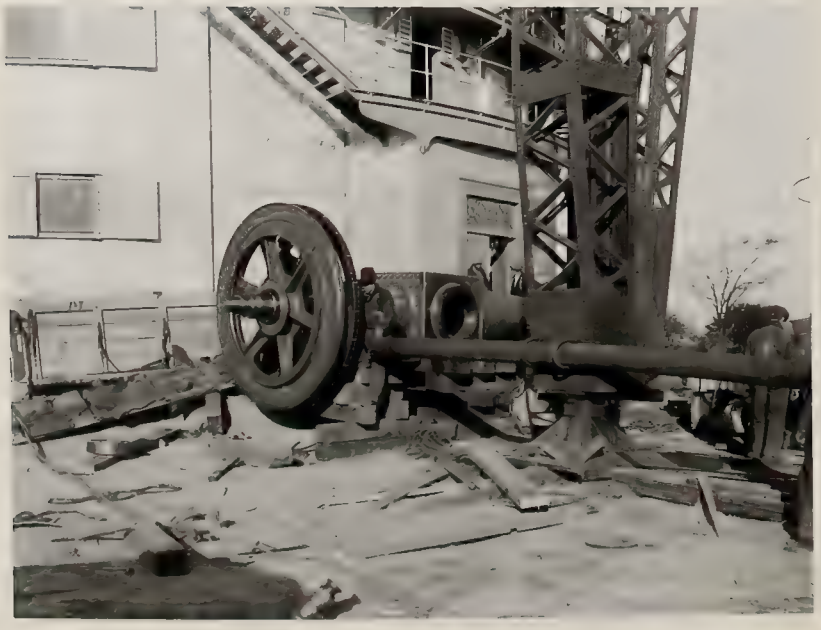
The dome and building was despatched in June and the telescope has recently been shipped.



tube centrepiece Monday Oct. 16, 1933 centrepiece Polar Axis

Three views of the Telescope as it arrived from Montreal, at the Dominion Bridge Works, Shaw St. Toronto.

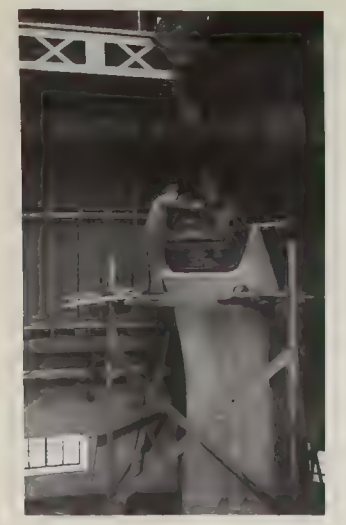
Oct. 16, 1933



Polar Axis being assembled, at the Base of the 20-ton crane. Friday, Oct. 20, 1933

Views taken Friday, October 20, 1933

Preparing the Housing of the lower bearing on the South Pier.



Preparing the Housing of the upper bearing on the North pier.

Within the Great Dome

★ ★ ★

1. Young

The Sidereal Circle is in place and the Driving Circle or worm wheel is being put on.

Shortreed Young Chant Sinclair (England)

2. Putting in place the large setting gear wheel.

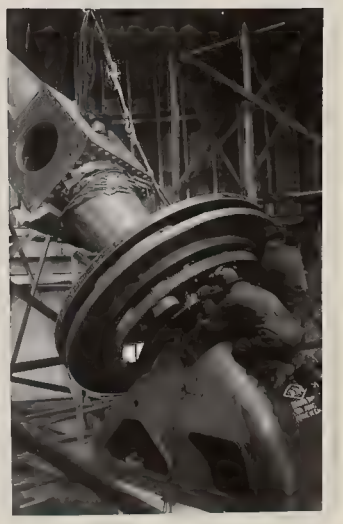
Three Views showing the Assembling of the Polar Axis

3. Putting on the Ball Bearing on which the lower end of the axis turns.

General View of Parts of the Telescope as delivered by truck to site.

Three Views taken on Saturday, Oct. 21, 1933, showing Preparations for hoisting the 16-ton Polar Axis

Sinclair



1. The Axis high in the Air

2. Just entering the slit in the Dome

3. Workmen guiding the lower end into its position

Three Views taken on the morning of Monday, Oct. 23, 1933 Showing the Hoisting of the Polar Axis. The whole operation occupied less than one hour.

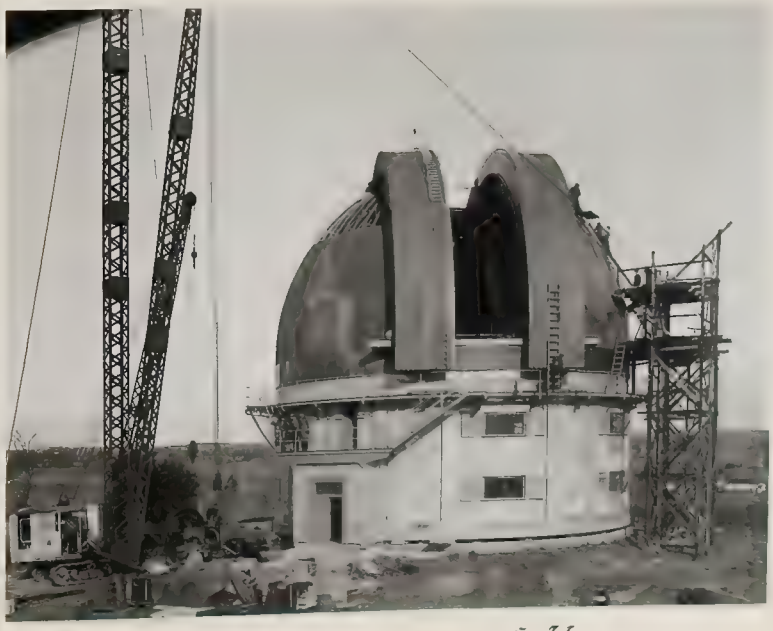
Three Views showing the Hoisting of the Declination Axis on the afternoon of Monday Oct. 23, 1933

1. The Axis high in the Air

2. About to enter the Dome.

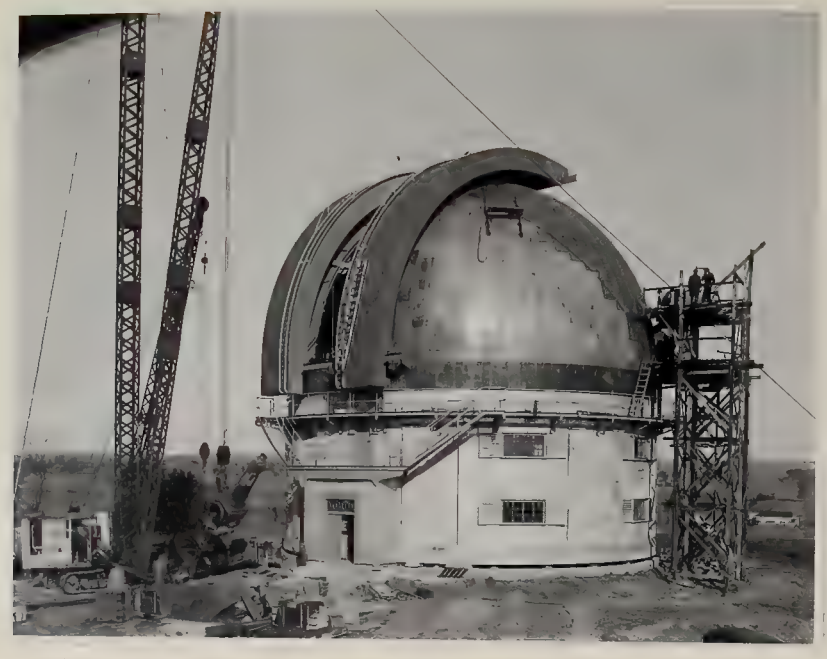
3. The Axis being put through the Cube of the Polar Axis.

Following are Seven Photographs of larger size, showing the Hoisting of the Polar and Declination Axes.

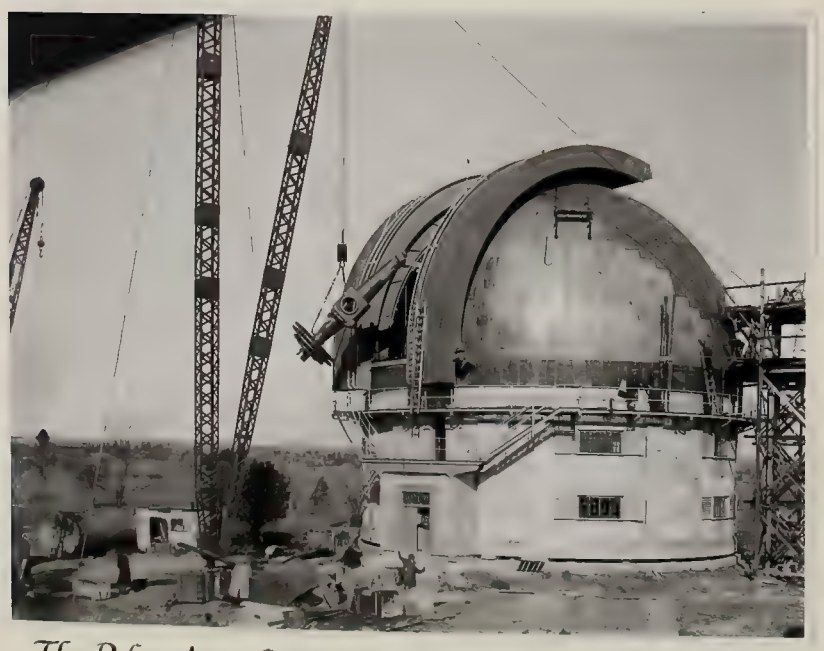


1. The Polar Axis on the Ground. Adjusting it for Hoisting. (The Polar Axis weighs 16-tons) Morning of October 23, 1933

Morning of Monday, Oct. 23, 1933



2. The Polar Axis just leaving the Ground.



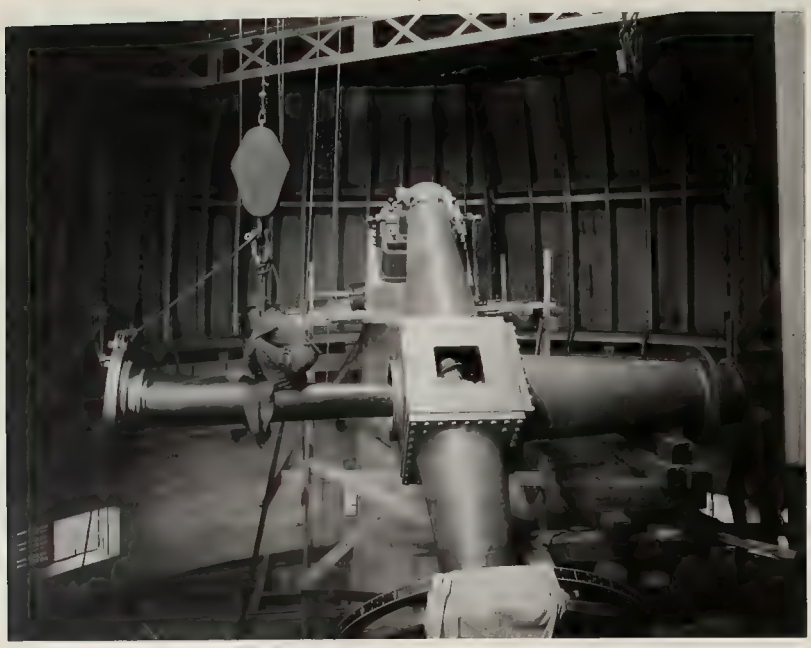
3. The Polar Axis about to enter the Dome.

Monday October, 23, 1933

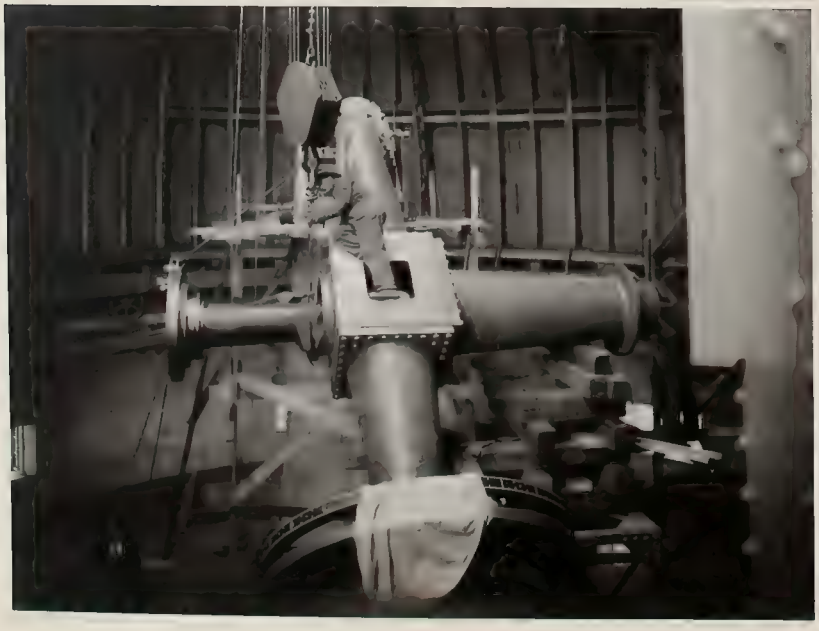
4. The Polar Axis almost within the Dome. Morning of Oct. 23, 1933

5. The Declination Axis entering the Dome. Morning of Oct. 23, 1933.

Afternoon of Monday, Oct. 23, 1933



6. Guiding the Declination Axis into position.



7. The Declination Axis moved farther into place.

Afternoon of Oct. 23, 1933

Photograph by A. Van

Photograph by A. Van

Two Views of the Observatory, looking Northeast, from a point just North of the lane and near the Railway. Taken at the end of October, 1933.
The lower picture was taken with an infra-red plate.

THE OBSERVER,
SUNDAY, NOVEMBER 5, 1933.

CANADA'S GIANT TELESCOPE.

INSTRUMENT WEIGHING 50 TONS.

ENGLISH MAKE.

A few miles from Toronto, on an eminence 800 ft. above sea level, a new Canadian observatory is being constructed as an adjunct to the University of Toronto, and the English firm of Sir Howard Grubb, Parsons and Co. have just finished constructing for the new observatory a reflecting telescope with an aperture of 74 in.

When this great instrument, which weighs over fifty tons, is in use Canada will possess the second largest telescope in the world, the only one which exceeds it in size being the 100-in reflector presented by Mr. John D. Hooker, of Los Angeles, to the Mount Wilson Observatory, California, by Canada's National Observatory at Ottawa has for some years possessed a 72-in reflector, equipped with the 74-in. instrument at Toronto, the Dominion can boast of the two biggest telescopes in the British Empire. The biggest telescope in the country to the 40-in refractor presented by Mr. W. J. Yapp to the Royal Observatory about a decade or two years ago.

But the Dominion is not content with possessing the second largest of Mount Wilson. Plans have been drawn up for one with a mirror 200 in. in diameter, which, it is proposed, is to be one of the peaks of the Rocky Mountains in Alberta. Unlike the majority of other reflecting telescopes, in which the mirror for the purpose is silvered, it is made of glass which has been specially cast as impracticable for a large mirror—but of fused quartz, and the makers, Thermal Electric Company, have offered to make the mirror for the modest cost of labour and materials.

Even the 200-in. telescope may soon be outclassed if American astronomers are to be believed, for it has been proposed that a 500-in. reflector, to be equipped with reflector, has been put forward by well-known American astronomers. Professor Todd has, indeed, even put forward a project for a 1,000-in. reflecting telescope which could be constructed, he believes, for quite a reasonable sum. He intends to use a fused quartz mirror for the 1,000-in. telescope, and would 12 inches thick for the mirror. The focal length of would be 1,000 ft. It was recently stated that Mr. Affel, of American millionaire, had promised to finance the project, but as yet no definite details have been published.

Many problems the solution of which astronomers had long sought have been solved by the aid of the Mount Wilson 100-inch telescope, the possibility being the size of the distant star. The diameters of which have been measured with this great tube for and its accuracy is unquestioned. It has also revealed many new stars to people stars, and, in conjunction with the spectrograph, some of these stars have been found travelling through space at speeds of many thousands of miles per second.

With one 200-in. reflector 1,000 stars can be seen something like 1,000,000 could be photographed with the 100-in. reflector, and it is estimated that an additional 500,000 can be photographed when the 200-in. reflector is in operation on the other peaks of the Californian Rocky Mountains.

September 12, 1933.—The seventeenth regular meeting of the Vancouver Centre was held at the University of British Columbia. The president, Mr. Teasdale was in the chair.

The president first welcomed the members to another season of activity, and made some announcements about the programme of meetings for the year.

Dr. G. M. Shrum then gave a short talk on the progress of the construction of the Dunlap Observatory at Toronto. While in the east this summer, he visited the site of the observatory as well as the plant of the Corning Glass Company where the disc for the 76-inch mirror is being cast from Pyrex glass. The observatory is being presented to the University of Toronto by the widow of the late Mr. D. A. Dunlap.

Dr. Shrum then described the unusual honeycomb contsruction of several discs for mirrors being produced for Mount Wilson, including that of diameter 200 inches, and showed slides of the equipment to be used in the pouring and annealing of the 76-inch disk.

From the Journal of the Royal Society of Canada. November, 1933

77 SPADINA ROAD,
TORONTO.
Dec 4 33

Sir, The Observer
. The admiration for
you
the . letter
.
.
in the enclosed clipping which I
me here to you on Sunday last in
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.

From Mrs. W. P. M. Kennedy

THE NEW YORK TIMES,
SUNDAY, DECEMBER 3,

WORK ON MEMORIAL NEARS COMPLETION

David Dunlap Observatory at University of Toronto Has a 74-Inch Reflector.

TELESCOPE LACKS MIRROR

Glass Disk, Cast at Corning, N. Y., Is Now in England Being Ground.

Special Correspondence, THE NEW YORK TIMES.

TORONTO, Nov. 30.—Work is proceeding vigorously on the David Dunlap Observatory of the University of Toronto, which is being erected by Mrs. D. A. Dunlap as a memorial to her husband, who died in 1924. He was connected with the mining industry in Northern Ontario and was well known for his support of philanthropic enterprises. The observatory is ten miles north of Toronto in York County, at an elevation of 550 feet above Lake Ontario, surrounded by 179 acres of land which will be made into an arboretum by the Faculty of Forestry of the university.

The Administration Building, a fine stone edifice 50 feet wide by 100 feet long, was completed some months ago. It is surmounted by three domes, which will house a 16-inch reflector, a 12-inch refractor, and a battery of astronomical cameras.

Reflector Measures 74 Inches.

The outstanding instrument of the observatory, however, is a 74-inch reflector, which at present is exceeded in size only by the 100-inch telescope of the Mount Wilson Observatory in California. The order for this instrument was given in 1930 to Sir Howard Grubb, Parsons & Co., of Newcastle-on-Tyne, England. This same firm undertook to supply the building to contain the telescope.

The circular building, 61 feet in diameter, is of steel construction covered within and without with sheet metal. The revolving dome has an inner and an outer covering of papier-mâché known by the trade name of agasote, and over the outside again is copper sheathing. The building, weighing 210 tons, arrived last July from England in a tramp ship which delivered it in Toronto harbor. It had been erected in England and a local bridge company took it to the site and soon re-erected it.

Telescope Quickly Placed.

The great telescope, all but the mirror, reached Toronto in September. Its weight is about fifty tons and it has been erected. One member of it, namely, the polar axis assembly, weighed over sixteen tons. It was lifted high in the air by a large crane, lowered through the 15-foot slit of the revolving dome, and placed upon the massive cement piers which were ready to receive it. The whole operation from the time it was on the ground outside until it was in its final position occupied less than an hour. Work is now being done on the elaborate electrical switchboard required to take care of the fifteen motors which control the telescope.

Unfortunately there was some delay in the difficult task of producing the large disc of glass for the mirror. But last March a contract for it was awarded the Corning Glass Works, Corning, N. Y. It was poured on June 21, and after three months of annealing was taken from its mould. An examination with the polariscope showed that its internal strains were small and that the disc was a good one. It was shipped to England, leaving Montreal on Oct 15, and is now being ground into shape at Newcastle. It is hoped that the mirror may be ready in a year.

The great project is being carried out under the direction of C. A. Chant of the University of Toronto.

Journal of the Royal Astronomical Society of Canada, 1933

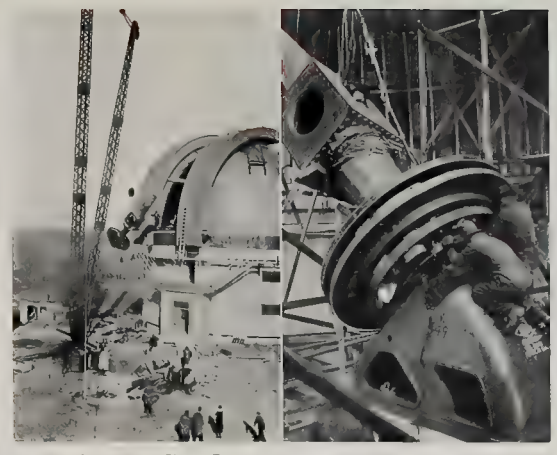
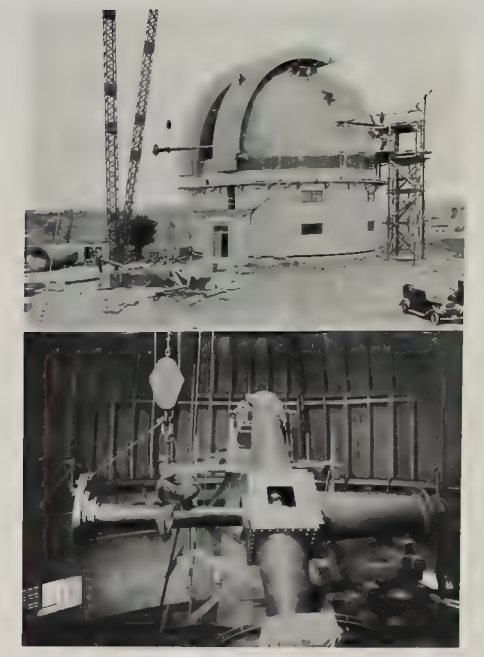


PLATE IX

ERECTING THE 74-INCH TELESCOPE OF THE DAVID DUNLAP OBSERVATORY
Left—Hoisting the polar axis. *Right*—Guiding the lower end into place.

PLATE X



ERECTING THE 74-INCH TELESCOPE
Above—Hoisting the polar axis. *Below*—Guiding this through the polar axis.
Journal of the Royal Astronomical Society of Canada, 1933

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Vol. XXVII, No. 10 DECEMBER, 1933 Whole No. 229

THE 74-INCH TELESCOPE OF THE DAVID DUNLAP OBSERVATORY

By C. A. CHANT

WITH PLATES IX AND X

THE photographs reproduced in Plates IX and X illustrate progress in the installation of the 74-inch telescope of the David Dunlap Observatory.

The circular building with its revolving dome arrived at the end of July. It was supplied by the firm which constructed the telescope, namely, Sir Howard Grubb, Parsons & Co. of Newcastle-on-Tyne. The structural part was produced by the Cleveland Bridge Co., of Darlington, but the intricate gear for revolving the dome, moving the shutters and wind-screens, &c., was made in Newcastle. As shipped it weighed 210 short tons. It was loaded on the steamship *Havtor* in England and brought directly to the Toronto harbour. From the dock it was taken by truck to the site fifteen miles away. The building had been erected in England and was speedily re-erected by the Dominion Bridge Co. of Toronto.

The diameter of the building is 61 feet and the walls are two feet thick. They are sheeted inside and outside with heavy galvanized iron. To bind the sheets together some 32,000 bolts were used. The revolving dome is sheathed with "agasote" a preparation of papier maché and a good heat-insulator. The outer covering is one-half inch thick and the inner one three-eighths of an inch. Over all is a covering of copper for protection from the weather. The covering of the dome was done by Sullivan and Fried, who erected the Administration Building with the domes on it.

The telescope—all but the large mirror—was shipped from Newcastle by the steamer *Cairnross*. At Montreal it was transferred to freight cars which brought it to Toronto. Then it was carted to the site and erected by the Dominion Bridge Co. As one piece of the telescope, the polar axis assembly weighed 161/2 tons a special 20-ton crane with a boom 92 feet long was erected to handle it. First, the housings of the bearings were carefully put in place on the north and south piers, and the axis was prepared. The driving and other wheels were placed on the south end; then when the large crane had raised the axis from the ground a second crane lifted one end until the axis was inclined to the horizontal at an angle of about 44° (the latitude of the site). The lower end was tied to the hook of the large crane so that the inclination of the axis should be maintained. Then the large crane raised the axis high in the air, passed it through the 15-foot slit of the dome and gently lowered it to the pier. The whole operation from leaving the ground until in its final position occupied less than an hour.

The left picture in Plate IX shows the axis in mid-air and the right picture shows the workmen guiding the lower bearing into its place. Then the declination sleeve weighing 3 tons was raised into position and bolted to the cubical portion of the polar axis. This was done on the morning of October 23.

In the afternoon the declination axis, weighing 31/2 tons, was raised and put in place. In the upper picture of Plate X the axis is seen passing into the dome, while the lower picture shows it being guided through the polar axis and the declination sleeve.

At the present date (November 27) the large switchboard with its relays for controlling the fifteen motors and their circuits is being erected on the ground floor. The ground and observing floors, which will be of cement, will soon be put in place.

The great disc of Pyrex glass, which was poured at the Corning Glass Works on June 21, after three months in the annealing oven was removed from its mould. By means of polarized light it was examined for internal strains and it was found to be exceptionally good. On October 5 it was shipped from Corning, N.Y., to Montreal and left that port on October 15 on the same ship which brought over the telescope. The disc is now at the optical works in Newcastle where it is being ground into shape.

DEATH OF LADY PARSONS

Lady Parsons died on October 16, aged 74 years, at her beautiful country home at Ray, about twenty miles from Newcastle-on-Tyne. She was the widow of Sir Charles Parsons, the inventor of the steam turbine, and known to astronomers as a son of the Earl of Rosse, who completed a 6-foot reflecting telescope in 1845, and also as the real head of the firm of Sir Howard Grubb, Parsons and Co., which has in recent years constructed a number of large telescopes, including the 74-inch reflector for the David Dunlap Observatory of the University of Toronto. Sir Charles died in February, 1931, and a sketch of his life appeared in this JOURNAL, volume 25, p. 185 (1931).

Lady Parsons' maiden name was Katharine Bethell, of Rose Park, Yorkshire, and she married Charles Algernon Parsons in 1883. Her intellectual ability and mechanical taste allowed her to appreciate her husband's great achievements. A son, Major A. G. Parsons, was killed in action in 1917 while serving with the Royal Artillery in France. A daughter, Miss Rachael Parsons, survives. She has the distinction of being one of the three women members of the Institute of Naval Architects.

Lady Parsons was buried beside her husband in the little village churchyard at Kirkwhelpington. The account of Sir Charles' life referred to above contained two plates, one being a photograph of Sir Charles and Lady Parsons taken at Ray by the present writer. A copy of the sketch was sent to Lady Parsons and I take the liberty of printing her reply below.

Ray Demesne
Kirkwhelpington, Northumberland
July 4th, 1931

Dear Mr Chant,

I received your letter of June 1st, and thank you so much for sending me a copy of the Obituary you wrote on Sir Charles. I think it is an excellent account of the main features of his life and work, and you have dealt with it all in a very appreciative and sympathetic manner. I am very pleased indeed to have it.

I had forgotten the photograph. It is very good in spite of the misty weather.

I hope very much that I shall meet you all again some day.

With many thanks

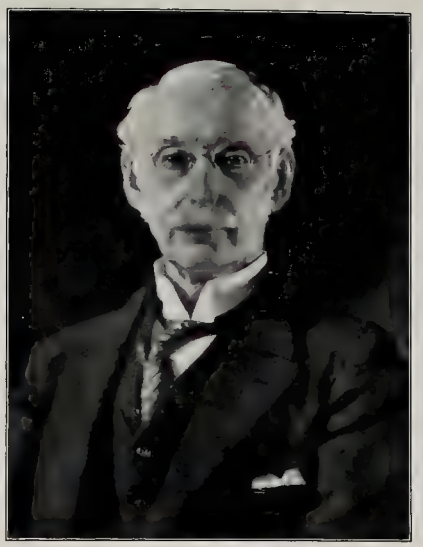
Sincerely yours

KATHARINE PARSONS

Journal of the Royal Astronomical Society of Canada
Dec. 1933

PLATE XIII

PLATE XII



HON. SIR CHARLES ALGERNON PARSONS, K.C.B., F.R.S., O.M.
Born July 13, 1854, died February 11, 1931
(From a Portrait by Orpen)

Reprinted from the Journal of the Royal Astronomical Society of Canada
May-June, 1931

SIR CHARLES PARSONS

BY C. A. CHANT

(With Plates XII, XIII)

THE recent death of Sir Charles Parsons, while on a pleasure cruise to the West Indies, came as a shock to his many friends and admirers. Though he had reached a somewhat advanced age, his activity of mind and body gave promise of further years of achievement.

Charles Algernon Parsons was born July 13, 1854, the fourth and youngest son of the third Earl of Rosse, who is famous in astronomical history as the constructor of the six-foot reflecting telescope of Birr Castle, Parsonstown, Ireland. Lord Rosse was born in 1800 and died in 1867. He graduated at Oxford University with first class honours in mathematics, and in later life he was a profound student of economics. While a youth he showed a special taste for mechanics and developed a remarkable manual dexterity.

Having leisure and means Lord Rosse looked about for the best way to employ his mechanical skill. Now Sir William Herschel died in 1822, and Lord Rosse admired exceedingly his skill in building reflecting telescopes as well as in using them. Herschel, it is said, had two hundred failures before he succeeded in making a satisfactory mirror; but ultimately he was able to produce one four feet in diameter, with a focal length of forty feet. Lord Rosse knew well that to construct such large astronomical instruments would try his mechanical ability to the limit, but he deliberately decided to make it the chief business of his life.

The material then used for telescope mirrors was an alloy of copper (two parts) and tin (one part). It is extremely hard and brittle, quite unlike either of its two constituents. It is very difficult to mould and the manipulation of the casting, after it has been made, demands experience and judgment; but it takes a fine polish and does not tarnish quickly.

After much experimenting Lord Rosse, in 1842, undertook to produce a mirror six feet in diameter and five inches thick—far larger than any attempted up to that time. He met many difficulties and had many failures but he would not give up, and the great telescope was completed in 1845. It was a scientific wonder of the world and remained unequalled in size until about fifteen years ago.*

In his father's workshop Charles Parsons learned to love mechanical pursuits. It is on record that in 1868 he and two brothers built a four horse-power steam "horseless carriage," which developed a speed of ten miles per hour; but it figured in an accident to a pedestrian and the father locked it up.

Sir Charles received his early education from the able young astronomers employed by his father to observe with the six-foot reflector—among them being Dr. G. Johnstone Stoney and Sir Robert Ball—and then, after a brief period at Dublin University, he went to Cambridge. In three years he graduated (in 1876) with high honours in mathematics (eleventh wrangler). In the same year he became an apprentice in the Armstrong ordnance works at Elswick, where he remained four years, devoting all his spare time to the study of steam. He next joined Messrs. Kitson, of Leeds, as experimentalist. This company manufactured a rotary engine which he had invented. Here he remained two years, until 1883.

Then he became a member of the firm of Clark, Chapman, Parsons and Co. His work on the rotary engine had directed his attention to the steam turbine. Many had attempted to solve the numerous problems involved in it and had failed, but this did not deter him—perhaps attracted him. He refrained from examining any of the previous patents, but attacked the general problem in his own way—from analogy of the water turbine. On April 23, 1884, he applied for two patents, and the history of the modern steam turbine began. The first patent covered a method of constructing a dynamo to run at the tremendous speed of 18,000 r.p.m.; the second was for a steam turbine on the same shaft, to drive it. Considering the rudimentary condition of electrical theory at that time, the construction of such a generator was an audacious project, while the turbine was entirely new. In less than a year a 4 k.w. dynamo and turbine unit was completed—the first successful turbine ever built.

During the next five years his firm constructed about three hundred turbo-generators of this type, the largest having a capacity of 75 k.w. During all this time Sir Charles laboured strenuously to improve the machines. Becoming somewhat dissatisfied, in 1889 he left the firm, but the latter, as the result of an arbitration, was allowed to retain the patents. The price asked for them was about £98,000, which Sir Charles would not give. Undaunted, in the same year he established the firm of Charles A. Parsons and Co. at Newcastle-on-Tyne, and resolutely set to work to produce a turbine on a different principle. In the original type the steam moved parallel to the axis; in the new one, radially outwards. In three years, in 1892, he produced a larger and more economical machine than the original one, though he still considered the parallel-flow method preferable. However, his old firm was not able to utilize the primary patents and Parsons got them back in 1894 for about £2,000. This gave him great satisfaction.

It was in this year Sir Charles began the application of the turbine to ships. A multitude of new and vexatious difficulties were encountered, arising chiefly from the excessive speed of rotation of the turbines. But one by one they were mastered, and in 1897, he made a grand demonstration of the use of turbines for marine propulsion. He equipped a little vessel, the Turbinia, one hundred feet long and nine feet wide, with engines of about 2,000 h.p., and at the naval review on the occasion of the Diamond Jubilee of Queen Victoria it raced up and down the line of warships at the unprecedented speed of nearly forty miles an hour. This performance drew universal attention to the marine turbine and its use in ships grew rapidly. In 1907 the Mauretania, of 40,000 tons displacement, with the turbine engines of 68,000 h.p., was completed, just ten years after the Turbinia, of 40 tons displacement. At present a great Cunard ship is being build which will have engines of 200,000 h.p.

As early as the nineties Lord Kelvin made the statement that the Parsons turbine was the most important development in steam engineering since the days of James Watt. The years since then have abundantly confirmed the accuracy of this remark.

Sir Charles Parsons had many other interests. One of these was the artificial production of diamonds. In various ways he subjected carbon to enormous pressures and temperatures, but without success. He would seldom give up a method without pushing it to the limit, and it is a pretty safe prediction that no one else will succeed where he failed. On these notable experiments about £30,000 was spent.

From his father Sir Charles inherited an interest in optical work. As early as 1887 he took up the production of mirrors for searchlights. As usual, he improved methods of manufacture, and devised a process for making mirrors up to seven feet in diameter, true to a desired shape. Nearly all the parabolic searchlight reflectors in Great Britain are from the Parsons works at Newcastle. He also made reflectors parabolic in one plane and hyperbolic or elliptical in the plane at right angles. Finding that there were many casualties among these mirrors he undertook an investigation into the glass from which they were made, which led to the production of a special heat-resisting boro-silicate glass, much more suitable for the purpose.

In January, 1921, he secured a large interest in the optical firm of Ross, Limited and became chairman of the Company. Here again his original mind and engineering genius suggested new methods of grinding which led to improvements in manufacture, with increased efficiency and a nearer approach to perfection in the finished products.

It is well known that at the outbreak of the great war Britain lagged far behind in the production of optical glass. This art, in which she was supreme a few decades ago, had been neglected, and the researches of Abbé and Zeiss in Germany had given that country almost a monopoly of this material. During the war the Derby Crown Glass Works had been established and it had been successful in producing glass of the highest quality; but after the war the urgency was gone and the continuance of the works was problematical. Sir Charles, of course, realized the importance of optical glass in the production of optical instruments; but no doubt his devotion to his country made him view the loss of such an industry with great misgiving. It is also believed that he was attracted by the possibility of making large lenses for telescopes. At any rate in July, 1921, he acquired the Derby Company, and its name was later changed to the Parsons Optical Glass Co. Once more his originality and experimental ability soon brought about many changes. He evolved a method of producing large discs and promptly accepted an order from Sir Howard Grubb and Sons for the flint disc for the 27-inch objective for Johannesburg. He then developed his own methods for much larger discs for lenses. He introduced improvements in the furnace in order to avoid breakage of the melting pot, he devised methods of stirring, thereby obtaining greater homogeneity; he overcame difficulties in handling the melted material and in annealing. In this way he succeeded in producing a pair of discs for a telescope objective 42 inches in diameter—slightly larger than the lenses of the Yerkes refractor. Some work has been done on these discs in the expectation of using them in a refractor for the Russian Soviet government.

The name of Grubb is highly honoured among the makers of astronomical instruments. Thomas Grubb, born in Kilkenny, in 1800, early in the century established a shop near Dublin. Among his products was the original equipment for nearly forty magnetic stations, one of which was established in Toronto in 1840, and has been in operation ever since, though removed to Agincourt in 1898. The Earl of Rosse often consulted Grubb in the construction of his telescopes; indeed they were friends with kindred tastes. Grubb's most notable production was the famous four-foot reflector at Melbourne, Australia. Thomas Grubb retired from active work in 1868 and was succeeded by his son Howard, who extended the business, making many instruments, large and small. In 1918 the works were moved to St. Albans, England, in connection with the manufacture of periscopes, as the firm had made a specialty of those instruments. Many makers of scientific instruments suffered in the aftermath of the war, amongst them the firm of Sir Howard Grubb and Sons. Sir Charles Parsons was interested, not only in the work of the firm, but also in its members and their family history, and it is pleasing to learn that in February, 1925, he acquired the business and the firm name became Sir Howard Grubb, Parsons and Co. Large and well-equipped shops were erected beside the turbine-electric works at Newcastle, and the firm was ready to construct astronomical equipment of the largest size. Since then some large instruments have been produced, including a 36-inch reflector for the Royal Observatory, Edinburgh; also a 40-inch reflector and a 24-inch refractor, with their revolving domes, for the new Stockholm Observatory. The order for the 74-inch reflector for the David Dunlap Observatory, to be erected near Toronto, was given in May, 1930, and it is to be regretted that Sir Charles did not live to see its completion. He was accustomed to the construction of mighty machines, some of them much larger than this instrument, but I believe he was thrilled with the prospect of producing a telescope excelling his father's masterpiece of 1845.

During his lifetime Sir Charles Parsons received many honorary degrees and medals. To enumerate them would take too much space, but three distinctions may be mentioned—F.R.S. in 1898, K.C.B. in 1911, and O.M. (Order of Merit) in 1927.

In 1883 Sir Charles married Katherine, daughter of W. B. Bethell, of Yorkshire. They had two children, a son, who was killed in 1918, in the war, and a daughter.

Sir Charles and Lady Parsons made many journeys together, including one to South Africa in 1929. Early in February last they started on a cruise to the West Indies. When some days out Sir Charles became indisposed, but nothing serious was suspected. On the 10th he seemed rather better and was able to sit on deck, smoking and chatting with his friends; but next day he became worse and quietly passed away at 8.30 p.m. on board ship, in the harbour of Kingston, Jamaica. The body was removed and taken back to England, where it was laid to rest with simple ceremony in the churchyard of Kirkwhelpington, on his estate about twenty-five miles north-west of Newcastle. Very appropriately a memorial service was also held in Westminster Abbey.

In closing my sketch of this great man I will quote a few remarks made by some who knew him much longer than I did.

Dr R. T. Glazebrook, in *Nature*.—

No one meeting Parsons casually would have recognized in the gentle, modest man, somewhat quiet and hesitating in speech and manner, one of the world's great benefactors. In public he said little but interest him in a problem, ask his advice on some knotty point of scientific or engineering practice, give him, perhaps, a little time for quiet thought, and your problem was solved, or if solution was not at once to be found, you were set on a track promising to lead to the desired end. Moreover, if the attainment of that end seemed of importance you secured for the rest of your journey the support and assistance of a most wise counsellor and, what is more, a most kind friend.

J. Hazelkus, Managing Director Ross, Limited —

He was uncanny in his ability to lay his fingers on the weak spot of any contrivance which had been much thought of by its originator, and here his great charm of manner was in evidence, so that no man hesitated to lay his ideas before him, and all were always the richer for the advice and help unstintingly given. Sir Charles had ready almost at once not one solution only, but several, leading to embarrassment as to which of them to choose.

A Scientific Friend in *The Yorkshire Post*.

No one can ever know the range of his help to those who had fallen on hard days, but it was inevitable that from time to time instances should become known. Most striking of all in this connection was his solicitude for those who in pain or sorrow were nearing their end. He would spare no trouble to cheer their days in some thoughtful way. On receiving the Order of Merit he wrote, "I think the congratulations of one's old friends give far more pleasure than any honour" no formal phrase, but sterling truth from him.

University of Toronto

Corrections to Sketch of Sir Charles Parsons

The present writer wishes to make three small corrections to his sketch of Sir Charles Parsons which appeared earlier in this volume (p. 185). He tried to be accurate in every detail but was not able to refer to original sources and had to depend on authorities which were not absolutely without error.

Sir Charles was the sixth son of the third Earl of Rosse. The second and third sons died in early boyhood, and of the four who grew to manhood he was the youngest. He left Cambridge University in 1877. In referring to the steam carriage constructed by Charles and his next elder brother it was stated that there was an accident to a pedestrian. This was in 1869. As a matter of fact, Lady Bangor, a cousin of the family, who was riding on it, fell off and was instantly killed.

The above corrections are made from an admirable obituary notice in the *Proceedings of the Royal Society*, prepared by "J.A.E." (Sir James Ewing), who is thoroughly acquainted with the scientific work of Parsons and was a personal friend since 1891.

C.A.C.

From the Journal of the R.A.S.C. Sept. 1931.

The Dunlap Observatory

DURING the past year we have casually noticed the new Dunlap Observatory in the course of construction just south of Richmond Hill

We have been particularly interested in its advancement owing to the fact that our Headmaster laid the corner-stone and because its donor, Mrs D A Dunlap, has always been so sincere a friend to St Andrew's College

The buildings are advantageously situated on a hill-top from where they command an unequalled view over the surrounding country, and are easily accessible from the highway

It was a bleak day I had chosen for my expedition and as I struck from a little road across to the buildings, the wind that swept unchecked over the open country tugged at my coat and almost buffeted me from my feet After hastily snapping a picture, I made for the huge dome which I knew contained the gigantic telescope It is enclosed by strips of shining copper broken only by the telescope-opening running from the centre to the circular walls, which are wholly of steel for the purpose of grounding any charges received in an electrical storm These greyish walls, relieved of their monotony by a few large windows, are encircled by a small platform, upon which a heated student might stroll if fatigued with his enthusiastic observing

Hearing the hammering and riveting from within I eagerly entered the building

The greatness of everything amazed me—perhaps it was the modernness of it all, or was it the men working high up on the huge metal tubing above? I did not know

Immediately a man approached me; it was plain to tell from his broad accent that he came from the north of England. I found out later that he had been especially sent by the manufacturers of the telescope to superintend its assemblage I told him my reason for being there and he kindly offered to show me round

I shall exclude the first few blundering questions I fired at him and let you profit by my extreme embarrassment and discomforture

The telescope was built at Newcastle-on-Tyne, England, and has been assembled by a Canadian bridging concern The size of a reflecting telescope depends entirely upon the dimensions of the main mirror which is enclosed in the bottom of the great machine.

This particular mirror, for which a special mould had to be built, is still in the process of setting; when completed it will weigh two and a

half tons and be seventy-four inches in diameter. When the telescope itself is finished it will weigh fifty tons and rank as the second largest in the world.

There are no lenses in a reflecting telescope, although some of us supposed there were; the actual observing is done, as the name implies, through the reflection of large mirrors. In the top are two of these; the

Newtonian for photographing, and the Casagrain, which would replace it for spectographing (that is examining the different colours of light).

The telescope is counterbalanced by large drums which secure the most amazing effect of all, namely, the ease with which it is controlled. On the mere pressing of a button a powerful motor turns at one hundred and ten revolutions per minute and the telescope is quickly swung into any required position within the dome.

"What is that steel framework for?" I asked, proud of my discovery

"When the big mirror is installed," explained the superintendent, "it has to be resilvered about twice a year That is an electric lift used for the removing of the glass, which otherwise could not be done without a great deal of trouble"

We climbed a narrow flight of steps to a steel walk encircling the interior of the dome From here I could see easily a long sort of tower swung out over us. This was the observer's platform equipped with one small wheel which could swing the big girder in the desired direction. The actual observing is done from here after it has been 'sighted" by several smaller finders secured to its sides

From the little platform high in the air I obtained a splendid view of both the unfinished floors beneath In all the observatories the domes are revolving, this one on large wheels running with a track, is driven by an engine installed on the ground floor

On descending to the little walk again, we passed engines for closing the massive dome

It is interesting to know that the temperature remains always the same as outside, because of the expansion and contraction of the glass.

Becoming confused with so much technical knowledge, after a vague hint, my guide led me across to the Administration building in which the business and studies of the Observatory are conducted

The building is of stone and most imposing with its three copper domes which lend to it the air of a Persian temple The lawn in front, I was told, is to be graded and planted with shrubs and flowers

The renovated home of Dr Chant, of the department of Astrophysics at the University of Toronto, is conveniently situated near the highway and within a few minutes walk from the Observatory

On entering the building I was struck with its brightness From the long hall branch the offices and class-rooms; the latter accommodate fifty students

The front hallway is beautifully finished in Italian marble and upon the floor are engraved the points of a true, coloured compass

The inscription, to the memory of the late David Alexander Dunlap, on highly polished marble with gold engraving, catches the eye immediately upon entering

A magnificent stair leads up to the second floor, and a smaller flight of steps to the three domes surmounting the building. Here the students are to do their own observing through the three telescopes, a large refractor, a small reflector and a celostat.

Having become so engrossed in my surroundings, I had not noticed how quickly the time had passed, and now it was growing dark. The

wind had stopped blowing—the clouds had been driven from the sky

As I opened the door, the last faint glow of the red sun fell upon the inscription:

"THIS OBSERVATORY
WAS PRESENTED TO THE UNIVERSITY OF TORONTO
BY
JESSIE DONALDA DUNLAP
AS A MEMORIAL
TO HER HUSBAND
DAVID ALEXANDER DUNLAP
1933."

THOMPSON,
Form V.

Nephew of Ernest Thompson Seton.

The Farm House and its Transformation.

Woodshed Kitchen — March 1, 1933
View from North.

April 27, 1933
View from South.

March 1, 1933
View from North-west

March 1, 1933
View from West

April 27, 1933
View from South-west

Brick oven — May 29, 1933
Tearing down Kitchen, Woodshed already removed

The Farm House being changed

July 11, 1933
View from North

August 16, 1933
View from South-east

View from South-west August 16, 1933

Janitors Apt. Sept. 7, 1933
View from South-east

The Director's Residence October 22, 1934
"Observatory House"

PRINTED ADVERTISING ROUS and MANN Limited 172 SIMCOE ST. TORONTO 2

October 24th
1932

Mrs. D. A. Dunlap,
93 Highlands Avenue,
TORONTO, Ontario.

Dear Mrs. Dunlap :

We are sending to you under separate cover, four airplane views of the property near Richmond Hill, showing the buildings of the new observatory from different angles.

We also enclose two views taken from ground level, in September, and suggest that the next picture might now be taken. Will you kindly let us know if you wish this done.

Yours very truly,

ROUS AND MANN, LIMITED,

JDM:BJ
ENCL.

ADDRESS ALL COMMUNICATIONS TO THE FIRM WITH ATTENTION OF MR. J.D.McCaul

ROUS and MANN Limited
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November 26th
1934

Prof. C. A. Chant,
Dept. of Astronomy,
University of Toronto.

Dear Sir :

The air pictures of the Observatory, about which you enquired, were taken on October 2nd, 1932.

Yours truly,

ROUS AND MANN LIMITED,

JDM:BJ

ADDRESS ALL COMMUNICATION TO THE FIRM WITH THE ATTENTION OF THE INTERESTED PERSON

ROUS and MANN Limited
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December 24th
1934

Mrs. D. A. Dunlap,
93 Highlands Avenue,
TORONTO, Ontario.

Dear Mrs. Dunlap :

I am sending you herewith the mounted sheets for the Great Record book. The titling is not completed as we have been busy dry-mounting the pictures in, but it will give some idea of the scope of the book.

As soon as you are finished with these sheets I will get them back and finish the lettering. I understand that Professor Chant has still some pages to come.

Wishing you the Compliments of the Season, I am,

Yours very truly,

A.H.Robson

AHR:BJ
ENCL.

ADDRESS ALL COMMUNICATION TO THE FIRM WITH THE ATTENTION OF THE INTERESTED PERSON

The Hon. Lady Parsons

a concave mirror placed at the back end of the tube. The image formed in each case is viewed through a magnifying lens, or combination of lenses, called the eyepiece

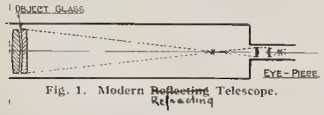

Fig. 1. Modern ~~Reflecting~~ Refracting Telescope.

Taking the Refractor first (Fig. 1), of which the ordinary field glass is an example, the usual form of achromatic object glass consists of two lenses, the outer component a double convex lens of crown glass, and the inner lens of flint glass, the surface adjacent to the crown lens being concave, while the fourth surface is generally a convex of long radius. All four surfaces have spherical curves. It is essential that the optical glass, from which the lenses are made should be of the highest quality, free from veins and striae, homogeneous or of equal density throughout and perfectly annealed

As these conditions are very difficult of attainment in large pieces of glass, there appears to be a fairly definite limit to the size of the refracting telescope, the largest so far constructed being that at the Lick Observatory, U.S.A., having an objective 36 inches in diameter, built in 1888, and the Yerkes telescope of the Chicago University, completed in 1897, which has an objective 40 inches in diameter. The production of a satisfactory disc of crown glass for the 36-inch Lick objective was only attained after nineteen failures

Another reason which places a limit to the useful size of the refractor is that the larger the lens the thicker it is necessary to make the glass, and a stage is reached where any gain in light due to the increased diameter is counterbalanced by the loss to transmission through the greater thickness of material

Now, turning to the Reflecting Telescope, the main mirror which collects the light must necessarily be of parabolic section, in order that all the rays from a star which to all intents and purposes are parallel, should be brought to a common or prime focus. This focus is formed away at the mouth of the tube, in the bottom of which the main mirror is fixed and as obviously the image formed could not be viewed there, it is necessary to introduce a second mirror in the cone of rays between the main mirror and the prime focus, in order to divert the image to a more convenient position. Various ways of doing this have been devised; thus, in the Gregorian telescope (Fig. 2) the

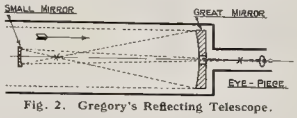

Fig. 2. Gregory's Reflecting Telescope.

main mirror has a hole in its centre, in which is fitted the eyepiece, which receives the rays from the main mirror after their projection on to a smaller mirror placed in an inverted position in the centre of the telescope tube. In the Herschelian reflector (Fig. 3) the main

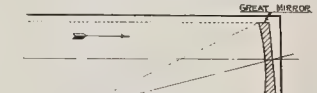

Fig. 3. Herschel's Reflecting Telescope.

reflecting mirror is tilted, causing the reflected rays to be projected to one side of the tube and near its mouth, at which point an eyepiece is inserted. Other forms are the Newtonian and Cassegrain, which are the only types now constructed.

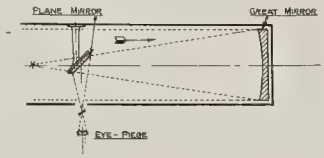

Fig. 4. Newton's Reflecting Telescope.

In the Newtonian form (Fig 4), devised by Newton about 1668, a plane mirror is fixed in the cone of rays at an angle of 45 degrees to

ON TELESCOPES

By C. Young, F.R.A.S.

MANY of us have paid our penny to have a look through a telescope at the seaside just to read the name of a ship, and some of us are the happy possessors of a pair of field glasses.

There is a certain fascination in being able to see more than one can with the unaided eye.

A telescope does not magnify in the sense that a microscope does, it does not make an object appear larger than it actually is. What it does is to bring it apparently nearer. The pupil of the human eye is about $\frac{1}{8}$th of an inch in diameter and can separate or distinguish between two adjacent objects whose angular distance apart is about 30 seconds of arc. With the aid of a 6-inch diameter telescope, the angular distance is reduced to one second, with a 12-inch to a $\frac{1}{2}$ second and so on

The late Sir David Gill, an Aberdonian, and H.M. Astronomer at the Cape of Good Hope Observatory, was once asked what he could see with his big telescope, a 24-inch refractor, and he replied that he would be able to pick out a threepenny piece if it was 8$\frac{1}{2}$ miles away

There are two distinct classes of telescopes; the Refractor, in which light is gathered together into a focus by refraction, or bending, through a lens or object glass placed at the front end of the tube, and the Reflector, in which the same end is attained by reflection from the surface of

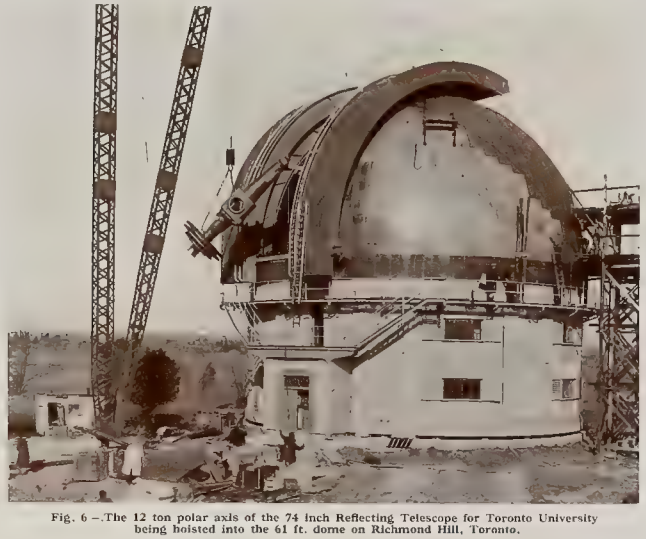

Fig. 6.—The 12 ton polar axis of the 74 inch Reflecting Telescope for Toronto University being hoisted into the 61 ft. dome on Richmond Hill, Toronto.

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the optical axis, in such a position that the focus is formed a few inches outside the periphery of the tube without any alteration of focal length. In the Cassegrain (Fig. 5), a form suggested by Cassegrain, a French sculptor, in

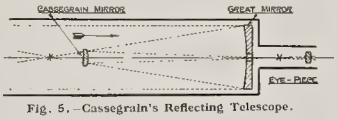

Fig. 5.—Cassegrain's Reflecting Telescope.

1672, the 45 degrees plane mirror is replaced by a mirror with a convex surface of hyperbolic section, coaxial with the main mirror, so that the cone of rays is reflected back and the focus formed a foot or so behind the main mirror, which in this case is provided with a central hole as in the Gregorian telescope.

This has the effect of increasing the focal length of the main mirror, usually by three or four times, according to the position and curvature of the second mirror, with a corresponding increase in magnification. Most of the existing large reflecting telescopes can be used either as Newtonians or as Cassegrains.

The limit to the size of the reflecting telescope, has, so far, been the difficulty in making a large enough disc of suitable material for the main mirror. All astronomical mirrors are silvered on the front surface

The parabolic mirror must not only be extremely accurate and symmetrical in form, but it must remain so in whatever position it is placed. For this reason it must not only be made thick, usually about one-sixth of its diameter, but must be evenly supported at the back, usually by pads mounted on a system of triangles.

Previous to about 1870, astronomical mirrors were made of speculum metal. As this metal only reflects about 60 per cent. of the incident white light, the loss of light due to the two mirrors was considerable.

The last big telescope with a speculum metal mirror was the 48-inch reflector built in 1867 by Sir Howard Grubb's father, Thomas Grubb, for the Melbourne Observatory, Australia. Since that time all large astronomical mirrors have been made of glass with a thin film of silver deposited on the front surface. Glass can be worked much more accurately than speculum metal, and a freshly silvered surface will reflect about 95 per cent. of the incident light. It is usually necessary to resilver the surface two or three times a year owing to the loss of light due to tarnishing of the silver film. This film is only about 1 200,000 of an inch in thickness and will not stand repolishing many times

The largest instrument of this type so far built is the 100-inch reflector at Mount Wilson Observatory, California, and the second largest, the 72-inch reflector of the Dominion Observatory, Victoria British Columbia.

Both of these instruments have been completed since the war. The 74-inch reflector (Fig 6), recently built at the Optical Works, for Toronto University will take second place, and Canada will thus possess two of the largest existing telescopes.

Mount Wilson Observatory, California, is planning to build a 200 inch reflector, but it is likely to be several years before this project comes to fruition

SIR HOWARD GRUBB, PARSONS & CO.

Since our last issue, the 61 ft Dome and 74-inch Reflecting Telescope Mounting have been shipped to Toronto and are now being erected on site.

The Pyrex Mirror Disc for this Telescope has recently been received from the Corning Glass Works. The grinding polishing and figuring of this mirror will probably take 12 months

The 18-inch Reflector for the Mill's Observatory, Dundee, and the 30-inch Reflector for the Royal Observatory, Greenwich, have been delivered and erected

The shops are at present engaged on :—

(1) Twin Refractor Tubes up to Leyden University

(2) Solar Telescope for Oxford University Observatory

(3) Mirror Balance for 72-ft Wind Tunnel for the Royal Aircraft Establishment, Farnborough

Two Views of the Main Mirror

Grinding the Mirror. The disc rotates and the Tool moves over it. Newcastle, Dec. 1933

The grinding Tool raised; the rough grinding of this surface completed. The disc is 76¾ in. in diam., 12 inches thick. Newcastle, Dec. 1933

The Reflecting Telescope for the David Dunlap Observatory

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Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Montreal, Que. February 8th and 9th, 1934.

Paper presented to the Engineering Institute of Canada

SUMMARY.—After explaining the principles on which reflecting telescopes are based, the author mentions the preliminary considerations which led to the placing of the contract for this large telescope. The general arrangement of the instrument and the various parts of its mounting and accessories are described, including the tube, the declination axis, the polar axis and driving gear and the driving clock. A brief description of the building and dome follows.

The principle of the telescope was discovered about the year 1608. The first famous telescope of Galileo was one and five-eighths inches in diameter and about twenty inches long. At that time the making of a telescope would not have been considered an engineering problem. The principles of the telescope are the same now as then but the increase in size from an inch or so to several feet makes all the difference. There is probably no instrument which necessitates the combination of technical and engineering skill to such an extent if the final product is to be satisfactory. A description of the 74-inch telescope of the David Dunlap Observatory, Toronto, will be of interest to members of The Institute.

The principles upon which a reflecting telescope is based are illustrated in Figs. 2*a* and 2*b*. In *a* the Newtonian form is shown, so-called after Sir Isaac Newton, its inventor. The light from a distant source is imagined coming from the right in a sensibly parallel beam which strikes the mirror *A*. The front surface of *A* is made hollow, being a paraboloid of revolution. This type of surface reflects the rays of all colours to the same point *D*, called the prime focus. In the Newtonian type of telescope, a plane mirror is placed at *B* in the path of the converging beam and inclined at 45 degrees to the axis, so that the beam is bent through a right angle and the focus is near *C*, where it may be examined with a magnifying glass or eyepiece.

In *b* we have the Cassegrain form of the telescope. The light which is reflected from the silvered glass mirror *A* in this case falls on a convex mirror *B* before it reaches the focus, and if the convex mirror is a portion of an hyperboloid of revolution, all the rays will be reflected back to a point near *C*. It is necessary in this case to have a hole in the centre of the mirror *A* to allow the light to reach the focus *C*.

These schemes look so simple that it is not at first apparent why it should be a difficult problem to make a telescope several feet in diameter. In the first place, however, the mirror *A* must be truly parabolic in shape with departures of the order of one-millionth of an inch. It must be very rigid to resist flexure and consequently heavy. The best material from which to make a mirror yet discovered is glass. In the instrument now described the mirror will consist of a solid disc about thirteen inches thick weighing about 5,000 pounds and made of pyrex. The advantages of pyrex are that it has a small temperature coefficient of thermal expansion and is a stable glass. The disc has been cast at the Corning Glass Works Corning, N.Y., and is now in England at the optical shops of Sir Howard Grubb, Parsons and Company, at Newcastle-on-Tyne, where it will be ground and finished.

In the second place the telescope must be capable of being pointed towards any object without loss of time and must be driven by some mechanism to follow the object continuously as it moves across the sky. It must not only keep the object in the field of view but must hold the image stationary. A drift of the image of a thousandth of an inch during the course of an exposure when the telescope is being used for photography would seriously affect the definition of the picture. The engineering difficulties confronting the telescope maker in thus keeping the tube so accurately pointed are about equivalent to keeping a gun pointed on a target an inch in diameter at a range of twenty miles while the target is moving at the rate of five feet per second.

The mechanical parts which support the mirrors are usually spoken of as the "mounting." The whole instrument must be sheltered by a building which can be opened to permit a view in any direction and provide means of convenient access for the observer to any part of the telescope.

The positions of objects in the sky are located with reference to imaginary circles drawn among the stars very similar to the circles of longitude and latitude on the surface of the earth. They are however given different names when drawn in the sky. Those which correspond to the circles of latitude on the earth are termed declination circles and that declination circle corresponding to the equator on the earth is termed the celestial equator. The angular distance of a star north or south of the celestial equator is called *declination*. The circles corresponding to longitude circles on the earth are termed right ascension circles and the corresponding angular co-ordinate is called *right ascension*. Right ascension is numbered from the zero right ascension circle and increases toward the east. Thus the position of any star in the sky is designated by its declination and right ascension in a manner very similar to the location of points in the earth's surface by latitude and longitude. Due to the rotation of the earth the sky appears to rotate about an axis, so that there are two points in the sky at which the earth's axis produced cuts the celestial sphere, and about which the stars seem to revolve. Of course, in the northern hemisphere only the north celestial pole can be seen and indeed its elevation above our horizon will be equal to the observer's latitude. Due to the rotation of the earth also the right ascension circles drawn among the stars come in turn to the meridian and that right ascension circle which coincides with the meridian is called the *sidereal time*. If any star on its right ascension circle is not on the meridian it is said to have an *hour angle* measured east or west in time from the meridian, the sky apparently rotating 15 degrees per hour.

The technique of telescope making has evolved gradually. Experience has had to point the way for advances and, as in other lines of engineering production, the changes are suggested by the weaknesses of former models. There are comparatively few firms that have sufficiently large machinery to handle the massive castings which support the optical parts, and, when we combine with this the fact that the number of firms which have had experience in telescope building is very small also, we see that the project could be tendered for by a very restricted few. In 1927, when Mrs. D. A. Dunlap expressed her willingness to provide the means to construct a large telescope, tentative specifications were drawn up and in June of 1928 sent to four firms, the Carl Zeiss Company of Germany, the Sir Howard Grubb, Parsons and Company of England, the Warner and Swasey Company of Cleveland, and J. W. Fecker of Pittsburgh. The preliminary specifications stipulated the general form of the mounting but left considerable latitude in detail. The Warner and Swasey Company did not submit any tender and the design of the Carl Zeiss firm was not attractive as it was of a very radical nature. There was not much difference in the designs of the other two firms but after due consideration it was decided to accept the tender of the Sir Howard Grubb, Parsons and Company, England. This was a very fortunate choice because the decrease of the pound sterling

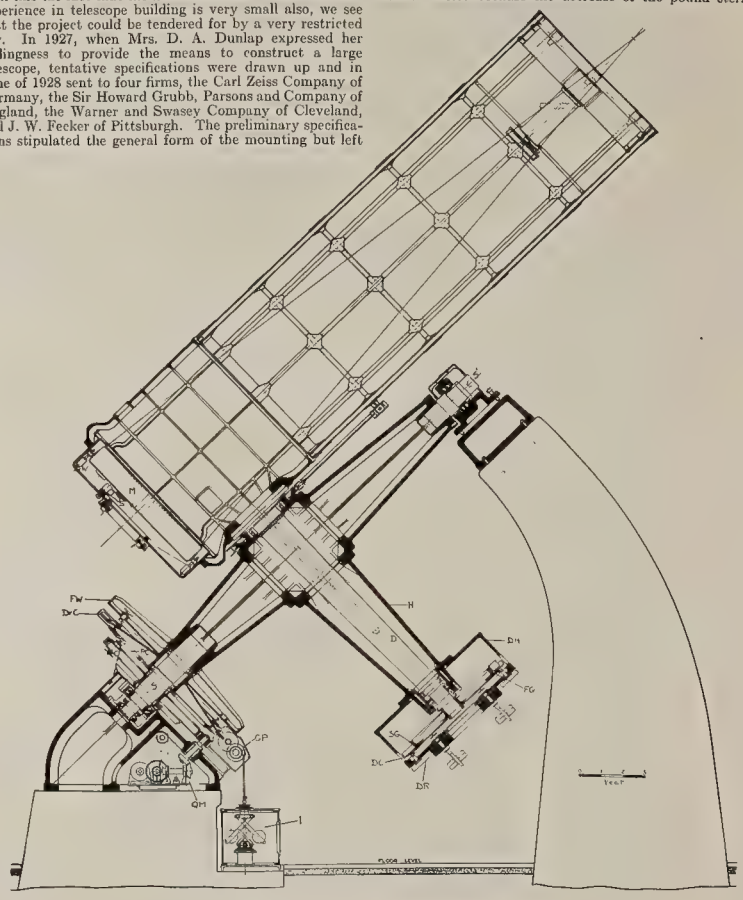
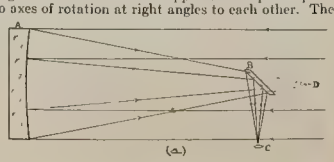


Fig. 1—General Arrangement of 74-inch Reflecting Telescope.

and the inflation of the American dollar later made the cost of the telescope very much less than it would have been had the contract been let in the United States.

The general form of the mounting is shown in Fig. 1 and a photograph as it appeared in the workshops prior to shipment is shown in Fig. 3. The essential features of any mounting are the tube which supports the optical parts and two axes of rotation at right angles to each other. The



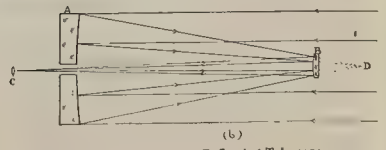


Fig. 2—Principle of the Reflecting Telescope.

polar axis (*SS'* in Fig. 1) must point to the celestial pole and the *declination axis D* to which the tube is attached provides another degree of freedom so that the tube may be pointed to any part of the sky. The polar axis is rotated by clockwork *I* in such a way that the telescope will continue to follow an object as it moves from east to west across the sky in its diurnal rotation. This is the equatorial form of mounting.

There are many forms of the equatorial mounting, which differ in the way the tube is attached to the declination axis, the latter attached to the polar axis, and the way in which the polar axis is supported. The kind of mounting selected for the 74-inch telescope is usually called the English type. As can be seen from Fig. 1, the polar axis is supported at both ends by two piers and the tube is carried on one end of the declination axis. In very heavy telescopes the polar axis is sometimes built in the shape of a large O and the declination axis supported by bearings at each end of the short diameter. This design is adopted in the mounting for the 100-inch telescope at Mount Wilson, California. In other telescopes the declination axis is attached to the polar axis beyond the two bearings of the latter. The 40-inch telescope of the Yerkes Observatory, Chicago, is an example of this type of mounting. In other telescopes again the polar axis is built in the form of a massive fork with two prongs and the tube of the telescope is mounted between the arms of the fork as in the 60-inch telescope of the Mount Wilson Observatory. Each type has its peculiar advantages in regard to strength, accessibility, and freedom of motion. The form adopted for Toronto has been very successful in the 72-inch telescope at Victoria, B.C.

When the contract was awarded in 1930 the main outlines only of the instrument were specified and Sir Howard Grubb, Parsons and Company began work on the detailed drawings. It seemed advisable toward the spring of 1930 for the author to spend some time in England going over the plans of the instrument with the manufacturer, and F. Jno. Bell, M.E.I.C., the Canadian representative of the firm, arranged to have the author visit Newcastle while the essential features were being drafted. This enabled much more rapid progress to be made than would have been possible if all the details had to be settled by correspondence.

On the author's arrival in England early in July 1930 the drawings were found well underway. Fortunately the firm had recently completed the 36-inch reflecting telescope for the Edinburgh Observatory and were engaged on a 40-inch telescope for the Stockholm Observatory. As there are many parts very similar in all telescopes, it was easy, from the parts of the 40-inch, many of which were in the workshop, to form a picture of the proposed new telescope. The completed drawings of the Edinburgh telescope were also a great help. In addition, the author had had a long experience with the 72-inch reflecting telescope at Victoria, B.C., and since the proposed mounting was very similar to this, conferences with Mr. Young, the manager of the optical works, enabled rapid progress to be made on the final design. When the author left towards the end of August no work on the actual construction had been done but the plans were so far advanced that construction was started in the fall.

The Tube

The tube of the telescope which immediately supports all the optical parts is made in three sections. These three sections are called the mirror cell, the centre piece, and the skeleton, and are shown in Fig. 1. There are several features that the tube must possess. It must be as light as possible but must carry the 5,000-pound mirror at the bottom and the small mirrors at the top with a minimum amount of flexure. It must permit a free circulation of air so that light rays, in their passage through the tube to the

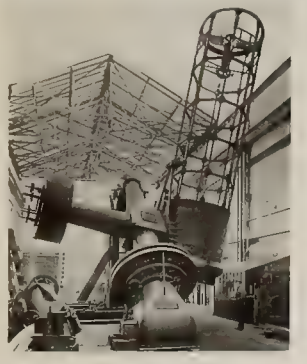


Fig. 3—Telescope with Tube Nearly Vertical.

main mirror and back, travel in a homogeneous medium. It must be capable of adjustment for alignment so that the optic axis is truly at right angles to the face to which the declination axis is attached. In order to reduce vibration to a minimum it should be mounted as close to the polar axis as possible.

The mirror cell consists of a steel-ribbed casting, weighing about 2,100 pounds. The mirror is supported on the bottom by a system of discs 7 inches in diameter in three sets of three each. These supports are shown in Fig. 1 at *S*. Each disc is mounted on a universal joint and the web-work which supports each set of three discs can be moved in or out to set the mirror with its face perpendicular to the optic axis. The disposition of the various discs is such that each carries its share of weight. Very careful attention was also given to the edge support. It is

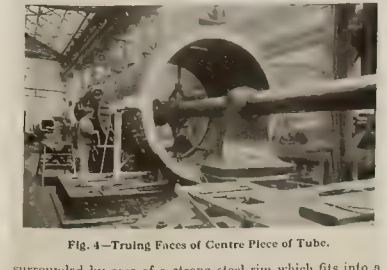


Fig. 4—Truing Faces of Centre Piece of Tube.

surrounded by arcs of a strong steel rim which fits into a groove in the disc. Heavy weights shown at *W* are attached to this rim by universal joints and are also attached by brackets attached to the interior wall of the mirror cell. When the tube is vertical there is no thrust on the edge of the mirror but as the tube assumes a horizontal position the weights act as levers with the brackets on the mirror cell acting as fulcrums and support the resolved component of the weight of the mirror so that in all positions the mirror is, as it were, floated. This might seem an elaborate system of support but the mirror is so sensitive to any distortional stresses that there is danger of the disc being warped if the stresses are not as uniform as possible in all parts. The mirror cell is bolted by a flange to the central casting.

Fig. 5—Iris Diaphragm at Half Aperture.

The centre piece of the tube is also of steel and is heavily ribbed, weighing 4½ tons. A boss is cast on one side where it bolts to the declination axis. Instead of making a perfectly flat contact between the flange on the declination axis and the centre piece, they touch along a rim only. The purpose of this precaution is to reduce the rate of flow of heat from the tube to the declination axis and thence to the rest of the massive parts of the telescope. This flow of heat has a tendency to take place in the early evening when the telescope is first put into use and the result seems to be that the part of the tube next the polar axis becomes a little cooler or warmer than the outer parts. There is then a temperature gradient across the disc and this produces a slight cylindrical warping and consequent astigmatism in the reflecting surface. It is necessary that the face of the boss and the two faces, where the mirror cell is bolted on at the lower end and the tube at the upper, be at right angles. The operation of truing these up may be seen in Fig. 4.

Immediately above the mirror and attached to the centre piece is an iris diaphragm similar in construction to that used in ordinary cameras. It is operated by a graduated hand-wheel on the outside of the tube and may be used to stop down the telescope and serves also as a protection to the mirror when closed. It is shown at half aperture in Fig. 5.

The skeleton part of the tube, which is bolted to the upper flange of the centre piece, is made of duralumin I-beams, cross-braced by rods also of duralumin threaded right and left hand at the ends into T-anchors By means of these brace rods, which can be seen in Fig. 3, the tube may be made to twist slightly or to shift in any direction without twisting. The rods are tightened to a point where each is under tension in any position of the tube. Careful

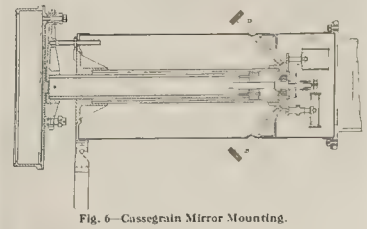


Fig. 6—Cassegrain Mirror Mounting.

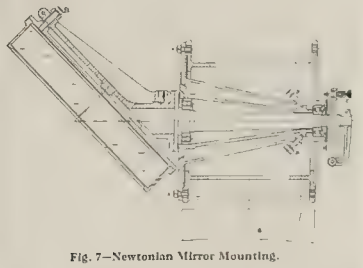


Fig. 7—Newtonian Mirror Mounting.

tests when completed have shown that, under the extreme position of flexure, the outer end does not sag more than one-sixteenth of an inch. The skeleton part of the tube supports at its upper end the secondary mirrors which may be of the Newtonian or Cassegrain form. The 74-inch telescope is designed to be convertible to either form. Figure 3 shows the Cassegrain mirror in place and in Fig. 1 the position the Newtonian mirror occupies is shown by dotted lines. Sectional elevations of these two attachments are shown in Figs 6 and 7. Very convenient arrangement is provided in both these mirrors for bringing them into alignment with the axis of the tube by means of the screws *BB*. By shifting the dowel pin *C* (Fig. 7) in the Newtonian form the mirror can be rotated and the rays of light brought to the side of the tube in any one of four positions. This is almost essential because, in working at the upper end, it is convenient to bring the focus to that side of the tube which is the easiest to reach. By loosening the screws *AA* the Newtonian may be removed and the Cassegrain fastens to the same flange. When the Cassegrain mirror is in place the observer is situated at the base of the tube for observation. In a large telescope of the reflecting type the changes in temperature, causing expansion and contraction in the tube and mirror, alter the position of focus. Changes in the focus may be made by altering the position of the Cassegrain mirror and in the 74-inch telescope this is done by a small motor mounted in the tube which attaches the mirror in position. The observer has only to touch a button at the lower end of the tube and the focus is adjusted in or out as desired.

The Declination Axis and Housing

The declination axis, to which the tube of the telescope is attached, consists of a steel forging 13 feet long with a flange at the inner end 3½ feet in diameter. Its weight is about 3½ tons. A hole has been trepanned through its centre to permit the electric wiring to pass to the tube and to the outer end. It is supported at the inner end by a

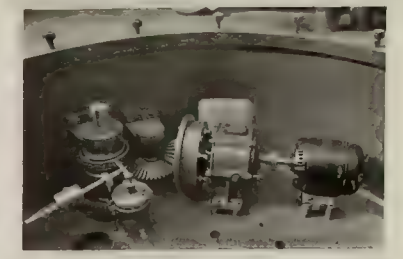


Fig. 8—Declination Quick Motion Gear.

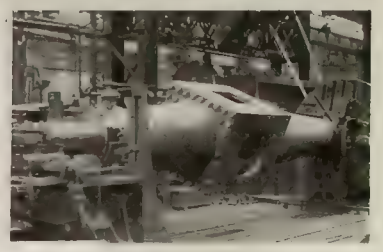


Fig. 9—Truing Polar Axle

radial ball-bearing 17 inches inside diameter, and at its outer end is carried by a radial bearing and double thrust bearing fitting into a tubular steel casting (*H* in Fig. 1) which is called the *declination sleeve*. All the bearings have been specially made with considerably less clearance than in commercial bearings. A spur gear (*SG* in Fig. 1) is keyed to the outer end of the declination axis which serves to turn the tube quickly in declination. The power for this motion is supplied by a motor inside the *declination housing DH* A photograph of this motor and gearing is shown in Fig. 8. It can be clamped or unclamped by a magnetic clutch, the controls for which are mounted on the pier of the telescope. Bolted to the large spur gear is a graduated circle *DC* (Fig. 1) which by an index enables the observer to read the declination at which the tube is set. This *declination circle* is divided to single degrees, but in order to read the declination more accurately a fine spur gear *FG* bolted to the graduated circle drives two small drums *DR*, and these are graduated to a least reading of five minutes. Small electric lights illuminate the declination circle and drums so that the reading may be conveniently seen from the operator's position beside the pier. The declination housing is made intentionally heavy so that its weight counterbalances the weight of the tube. Additional weights are attached to the housing to adjust the balance. It can be seen from Fig. 1 that no extra weight has been attached to the declination axis proper, thus reducing flexure to a minimum and facilitating a free motion in declination. When the telescope has been brought to the correct declination setting, within a minute of arc, the quick motion gear is disengaged and the observer, on looking through the telescope, will see the star, but usually not in the centre of the field of view. It is necessary to have some fine adjustment whereby the tube may be moved by very small amounts The mechanism which effects this is called the *declination slow motion*. It is shown in Fig. 1 and in Fig. 3 between the polar axis and the tube. A fabricated steel arm about seven feet long is mounted on a V-ring which can be clamped or unclamped to the polar axis. The outer end of the arm carries a nut mounted on a hub motion which can be moved in either direction along a screw attached to a bracket fastened on the tube. A motor operates a two-speed gear to turn this screw for giving the slow motion in declination The motor is operated by two separate switches. For the faster motion a dog-clutch, operated by a solenoid in parallel with the motor, connects the gear to the slow motion screw and moves the tube fifteen minutes of arc in one minute of time. For the slower motion an electro-magnet brings a differential gear into action and the tube moves thirty seconds of arc in one minute of time. The circuit which actuates the magnetic clutch in the declination housing for quick motion is interlocked with the clamping motor on the V-ring so that it is impossible to have the two clamps engaged at the same time.

Fig. 10—Right Ascension Slow Motion Clamp

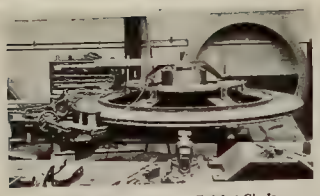


Fig. 11—Cutting Teeth in Driving Circle.

The Polar Axis and Driving Gear

The polar axis, which carries the declination axis and housing, is best seen in Fig. 9 where it is shown on a lathe. It consists of three sections, a central hollow steel cubical casting to which is bolted two tapered hollow steel castings. Forged steel pivots are shrunk into the ends of the steel castings. Figure 9 shows the operation of truing the polar axis. It is 22 feet long and weighs 9½ tons. Having been trued up it was never taken apart but henceforth treated as a unit. It runs in self-aligning ball bearings with a ball thrust bearing at the lower end. The housing at the upper

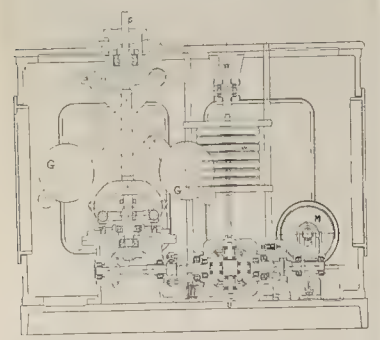


Fig. 12—Driving Clock.

end provides means of adjustment in elevation and azimuth to bring the axis SS' in line with the celestial pole. Keyed to the lower end of the polar axis is a large spur gear S which engages with the quick motion motor QM in Fig. 1 for moving the telescope in right ascension. This motor is engaged with the gear by a magnetic clutch. When the clutch is engaged and the motor started, the telescope rotates in right ascension, and in order to bring the telescope quickly to rest when the motor is released, the clutch continues to engage for a few seconds and acts as a drag. This is a very convenient arrangement in preventing the overrunning of the telescope beyond the desired reading. The *driving circle* (*Dr. C* in Fig. 1) for moving the telescope to follow the motion of the stars is mounted on the lower pivot immediately above the quick motion spur gear. It turns freely on ball-bearings but can be clamped to the axis through the spur gear. The clamping arrangement is shown in section at *RC* in Fig. 1 and a plan is shown in Fig. 10. A small motor (*A* in Fig. 10) rotates the arm *C* and the toggle arms *B*, which are mounted eccentrically, push out wedges into a V-groove on the inner edge of the driving circle. The driving circle itself is a steel casting, and a bronze rim, in which the teeth are cut, has been shrunk onto its outer edge. The pitch diameter is 8 feet cut into nine hundred and sixty teeth. The operation of cutting the teeth in this wheel is shown in Fig. 11, in which it will be observed that a finely divided silver circle is mounted directly over the worm wheel. The positions of the teeth are governed by the divisions on this circle so that the driving circle is a copy of this tested circle. This procedure eliminates the danger of periodic errors. The teeth were carefully hobbed and ground and the worm finally run in with rouge to ensure a perfectly smooth fit. Mounted above the driving circle at *FW* in Fig. 1 is a free wheel called the *sidereal circle*. It is mounted on the boss of the driving circle and can be easily rotated by any one of six hand-wheels attached to it and fitted with pinions gearing into a wheel attached to the driving circle. The metal rim of this wheel is 3 inches wide and graduated on both edges to one minute of time divisions. The lower set of divisions read against indexes fixed to the guard of the driving circle and therefore mark sidereal time, while the upper set of divisions are read by indexes which are attached to the polar axis and therefore read right ascension. On starting work at the beginning of the night the clock is started and the sidereal circle moved by means of the hand wheels till the lower graduations read the correct sidereal

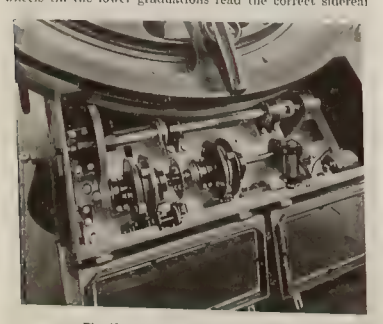


Fig. 13—Gear Plate and Driving Worm.

time. As the sidereal circle is attached to the driving circle the lower scale will continue to read the sidereal time. In order to set the telescope on any star it is necessary only to engage the quick motion and turn the telescope about the polar axis until the upper scale reads the right ascension of the object. The driving circle is then clamped to the polar axis and the quick motion clamp freed. The quick motion clamp in right ascension and the clamp for the driving circle are actuated by an interlocked circuit so that it is impossible to have both on at the same time.

The Driving Clock

The position of the driving clock is shown at *I* in Fig. 1 and a cross-section through the vertical spindle is given in Fig. 12. The cross-arm governor *G* is driven by the weight *W*. The motor *M* turns at the right speed to keep the weight floating on its vertical guides. Ordinarily if the motor is turning at the correct rate the position of *W* will be stationary and the outer housing of the differential gear *U* will be at rest. But if the motor turns too fast or slow the weight rises or falls and the outer housing turns, without affecting, however, the torque applied to the governing spindle. In order to keep the weight *W* suspended and to govern the motor, the weight is attached to a lever arm, not shown in the drawing, which actuates a resistance in series with the motor slowing the latter down if the weight gets high and speeding it up if the weight falls low. As the governors speed up, the link motion spreads and brings into play two friction pins at *FF* and the speed is checked. The moment that these engage can be regulated by turning the heavy weights *GG* which are mounted eccentrically. A clock of this type runs very accurately but not with the precision necessary to keep the image of the star perfectly stationary. Therefore, instead of gearing the spindle *S* directly to the driving worm, it communicates to a gear plate shown at *D* in Fig. 13. If the clock is driving at exactly the right rate this shaft turns one revolution in twenty-four seconds. Mounted on this shaft at *CC* is a thin disc in the circumference of which are cut twenty-four V-shaped notches, and into these notches beats the armature of a solenoid which is connected to the seconds beat of a sidereal master clock. Provided the disc *CC* runs at the correct rate the armature accurately strikes the depressions but if the wheel runs too fast or slow the armature shifts the wheel slightly and it is connected with the differential *HM* to keep the worm drive in synchronism with the notched wheel *CC*. For a slow

Fig. 14—View of Site from Southeast showing Piers.

motion the differential *HM* may be rotated by the motor *M* and for a still finer motion the differential *GM* can be locked or released by a dog-clutch. The motion imparted by the motor *M* is never sufficient to completely overcome the normal rate of drive so that the driving screw is always engaged with the driving circle and hence all difficulties of backlash avoided.

The complete mounting as described above was received in Toronto on October 15th, 1933.

The Building and Dome

The building to house the telescope, though out of the line of ordinary construction, did not require so long to complete. The contract for it was let in November 1931, and it was received on July 31st, 1933. In the meantime the piers to support the telescope and the foundations of the building had been built.

Fig. 15—Building with Dome Partially Erected.

Figure 14 shows the cement piers in place and the nature of the surrounding country. The site chosen is a hill about 800 feet above sea level and 100 feet above the surrounding country, 12 miles north of the city limits of Toronto. The piers consist of reinforced concrete and extend 25 feet underground to a foundation of hard clay which extends farther down for more than 150 feet. On the east side of the pier a pit 6 by 10 feet extends to the bottom of the foundations. An elevator is mounted in this pit for removing the mirror and mirror cell. The mirror can be readily taken off for the purpose of resilvering.

Fig. 16—Observing Platform.

Figure 15 shows the circular building and dome as it stood at the end of September. Since then the telescope has been put in place and the dome covered. As the construction of the building and dome presents a number of unusual features a brief description will be of interest. The entire building is of steel construction. The circular base and dome have double walls, and open louvres at the base of the building admit air which circulates to the top and exits through baffle plates at the top of the dome. The inside and outside of the dome is covered with "agasote," a kind of hard paper product, and the outside is further protected by a sheeting of copper. By this means the interior is kept cool during the day and in the evening when observations are started the whole building soon assumes the temperature of the outside air and the definition is not interfered with by heated air currents which would undoubtedly be the case if any quantity of heat were stored in the walls.

The dome, which weighs about eighty tons, rests on twenty-four rollers 27 inches in diameter mounted on self-aligning ball bearings and running on a circular track. Lateral rollers keep the dome in position as it is rotated. The rotation is effected by means of an endless steel cable passing around an annular channel ring fixed to the base of the dome and over two tangent pulleys to a winding gear. The dome is 61 feet in diameter and has an opening at one side, 15 feet wide, extending from the bottom to 7 feet beyond the zenith. Two parallel shutters run on rails at the top and bottom of the dome and are operated by wire ropes connected to a motor-driven gear which opens or closes the two shutters simultaneously. To protect the telescope from wind blowing in at the open shutter, two wind screens, motor operated and consisting of heavy sail cloth, can be used to cover the part of the opening not in use. One runs from the top of the opening downward and the other from the bottom upward and are guided in tracks fixed to the inside of the shutter opening. A novel feature of the dome, and one which should make it more convenient to operate than any previous models, is the method of access to the upper end of the tube. Two parallel segmental platforms are fixed to the inside of the dome, the lower one at the base of the opening and the upper one at a 16-foot higher level. Rails are mounted on these platforms and a circular arc bridge connects the two platforms. The bridge is shown in Fig. 16. The entire bridge can be moved laterally on the rails of the platforms and a small observing carriage travels up the curved arch. The small observing platform can be swung around on a pivot to enable the observer to place himself in a convenient position with respect to the eye-piece of the telescope.

No effort has been spared by the manufacturers to make the entire mechanism, mounting and dome in the best way possible. The workmanship is of the highest quality throughout and when finally completed the telescope will be the largest in the British Empire.

The magnitude of the telescope will make it a powerful instrument of research, and the major part of the programme of the observatory will be devoted to investigations into the motions and distribution of the stars. One evening per week however will be devoted to viewing the heavens when the public will be invited to visit the observatory and look at the planets, the moon and other objects in the sky.

Note: The illustrations, with the exception of Figs. 14 and 15, which are from photographs taken from the roof of the administration building of the observatory, are from photographs and drawings kindly supplied by the Sir Howard Grubb, Parsons and Company.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XVII FEBRUARY 1934 No. 2

A New Canadian Observatory

Much of the recent progress in astronomical knowledge has related to the stars and nebulae, and is the result of patient observation with greatly improved equipment. This has furnished astronomers with a mass of information on such matters as the stars' temperatures, motions, distances and constitutions, all based on the study of the messages which the astronomer deciphers from the light sent to him from the skies. In fact, astronomy has become closely connected with atomic physics and the astronomer and the physicist are working hand in hand. For such investigations the astronomer needs instruments of a capacity and precision undreamt of in the days of Newton and Huygens. Of these, the most important is, of course, the telescope with its photographic and spectroscopic accessories.

The design and construction of a great telescope is now an undertaking which requires the highest skill of the mechanical and electrical engineer, and presents manufacturing and optical problems which very few engineering works are able to solve successfully. As Dr. Young points out in his paper, printed elsewhere in this issue of The Journal, it is necessary to design an instrument which can be moved slowly and with extreme accuracy, although weighing many tons, so as to follow exactly the motion of a celestial object. Further, if the image of the object is to have the necessary clearness of definition, the deformations of the telescope structure and the mirror it carries must be kept within very minute limits, whether such distortions are due to temperature changes or to the weight of the parts of the instrument itself.

The paper describes the way in which these objects have been attained in the construction of the new 74-inch telescope for the David Dunlap Observatory of the University of Toronto. The provision of this instrument and the building which houses it was due to the efforts of Professor C. A. Chant, head of the Department of Astronomy of that University, who for the past twenty-five years has urged the establishment of a research observatory there. In numerous public lectures, in The Journal of the Royal Astronomical Society of Canada, and in the courses in astronomy within the university, the need of an observatory was constantly stressed.

During his life, the late David A. Dunlap took a keen interest in astronomy and in the meetings of the Astronomical Society. When, therefore, some time after his death, Dr. Chant approached Mrs. Dunlap with the proposal that she erect an observatory as a memorial to her husband, the project was very sympathetically received, and as a result plans were made for the observatory, the account of which we are now privileged to publish.

Some of the largest telescopes of the world are listed below:

1. The 100-inch reflector at the Mount Wilson Observatory, California.
2. The 72-inch reflector at the Dominion Astrophysical Observatory, Victoria, B.C.
3. The 69-inch reflector at the Perkins Observatory, Delaware, Ohio.
4. The 60-inch reflector at Harvard College Observatory, Boston.
5. The 60-inch reflector at the Mount Wilson Observatory, California.

The telescope for the new David Dunlap Observatory will have an aperture of 74 inches. It will therefore be the second largest in the world, and its construction gives Canada two reflecting telescopes of the first rank.

The new telescope will be devoted almost entirely to astronomical research. The advantage which it will possess over smaller instruments is due to its great light-gathering power. Taking the light-gathering power of the unaided eye as a unit, that of various sized telescopes may be expressed in terms of this unit. A 2-inch telescope would possess 64 times the light-gathering power of the eye, a 10-inch telescope 1,600 times and a 74-inch telescope 87,616 times. Possibly another and more striking way to illustrate the effectiveness of the large telescope is by a comparison of the number of stars which can be seen in telescopes of various sizes. There are about 4,000 stars visible to the naked eye in the whole celestial sphere on a clear moonless night. A 2-inch telescope will show about 300,000 and with the 74-inch telescope it will probably be possible to photograph over 500 million. Thus the ability of the large telescope to photograph faint stars enables it to reach far out into the depths of space.

When a spectrograph is attached to the telescope the spectra of the stars can be photographed and it is possible to determine their constitution, temperature, distance and speed of motion in the line of sight. To photograph the spectrum of a star at the limit of naked eye visibility requires about two hours with a telescope of 15-inch aperture; with the 74-inch this exposure time can be reduced to ten or fifteen minutes. Thus a great deal more work can be done in a given time with the larger instrument. The actual difference in practice is greater than these numbers indicate, owing to the danger of the long exposures being ruined by clouds and other troubles.

But there is another advantage of the large telescope over the small, and that is the clarity with which it shows detail on any surface. The layman thinks of this as magnifying power; a better term is resolution. In order that detail may be seen on an object it is necessary that the images of two nearby points of the object be seen as two separate images in the telescope. The smaller the angular separation of two points which can be seen apart, the greater the detail which can be made out. This ability to distinguish contiguous points is called resolving power and it varies directly with the aperture of the telescope.

In order that the full resolving power of a telescope be developed it is necessary that the beam of light from the source pass through a perfectly uniform medium and ordinarily even when the sky is clear the atmosphere of the earth is very far from this condition. In looking at the stars through a small telescope of 2-inch aperture the uniform beam of light needs to be two inches in diameter only, but in a 74-inch telescope there must be a uniform beam 74 inches in diameter. The former condition is met with on very many more nights per year than the latter. It therefore happens that the casual visitor to an observatory may be disappointed with the clarity with which he sees the moon or planet through the large telescope, often not better than through a much smaller instrument. The fault does not lie with the telescope but with the atmosphere. When the latter is steady, or, as an astronomer would say, when the "seeing" is good, the full aperture can be utilized to advantage and much more detail seen. The observer must seize these opportunities to do his best work.

The new telescope will be used on every available clear night from sunset to sunrise in photographing the stars or obtaining their spectra. An observatory however would not be fulfilling its complete purpose if used entirely for research. Part of the time must be devoted to those interested in seeing the wonders of the skies and it is planned to set aside one evening per week when the observatory will be open to the public and the telescope available to them. From such a visit some idea may be gained of the patience and skill which the observer needs in order to keep a star image on the slit of his spectroscope, or obtain a clear photographic record in spite of adverse atmospheric conditions and the necessity for prolonged exposure.

CANADIAN CHEMISTRY AND METALLURGY
March 1934

TORONTO CHEMICAL ASSOCIATION

Armour Plate Glass—Laminated Safety Glass—
Dunlap Telescope Lens
Large Lens for Dunlap Observatory

Prof. C. A. Chant gave a very interesting description of the difficulties encountered in securing the large 76-inch lens required for the new telescope at the Dunlap Observatory. The contract for the entire telescope was let to the firm of Sir Howard Parsons in 1930, and the first glass company approached was a subsidiary of that firm at Derby. They hesitated to tackle the job, and after much delay a commercial glass concern in England offered to produce the lens from crown glass in 15 months.

In the meantime Prof. Chant heard of the experimental work being done at the Corning Glass Works in the United States, in preparation for a 200-inch lens for California. A special grade of Pyrex glass was prepared for this purpose, with an exceptionally low coefficient of expansion. This huge lens was to be made with a honeycomb structure on the lower side, in order to cut down its weight and time of cooling.

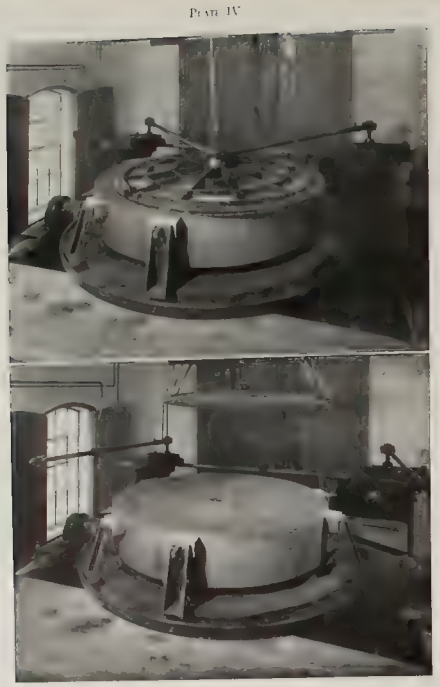
About the time Prof. Chant communicated with the Corning Glass Works, they had produced an experimental 60-inch lens and had little hesitation in accepting the contract for the 76-inch one required here. The telescope having been built for the greater weight, the honeycomb principle was not employed, but the one side of the lens was cast concave to reduce the grinding.

Casting the Lens

In casting the lens, the glass from a great 75-ton tank was at a temperature of 1,500° C. was transferred to the mould, which was kept at 800° C. under a low-flame heater. After the pour, the temperature was raised to 1,250° C. for 12 hours, to secure homogeneity. The lens was then lowered to the annealing kiln, soaked at 530° C. for 2 days, allowed to cool 2.2° per day, until a temperature of 380° C. was reached, and the rate of cooling speeded up to 10° per day. Previous attempts at casting, the lens was examined under the polariscope and satisfactory are stopped to regard for grinding. The grinding process will require nearly a year, and the finished lens will arrive about the end of 1934.

The meeting was under the auspices of the Canadian Institute of Chemistry, with Mr. A. R. Bonham in the chair. The President of the Institute, L'Abbé Alexandre Vachon, was present and brought greetings from Quebec to the Toronto group.

PLATE IV



THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

Vol. XXVIII, No. 3 MARCH, 1934 Whole No. 232

THE 74-INCH TELESCOPE OF THE DAVID DUNLAP OBSERVATORY

By R. K. Young

(President's Annual Address, January 16, 1934)
(With plate IV)

THE buildings and preliminary equipment for the David Dunlap Observatory are nearing completion. The Administration Building is finished. It will provide space for offices, for library, and for laboratories required in the measurement of the photographic plates and in subsidiary investigations. The copper-covered steel dome and circular building for the large telescope has been erected, although considerable work still remains to be done. The mounting for the telescope is in place. The large mirror is at present in England being ground (see Plate IV), and is expected to be ready within a year.

The two buildings stand out clearly on the sky line to the east as one travels north on Yonge St. between Thornhill and Richmond Hill. The Administration Building is built of stone along classical lines, and does great credit to the architects. The building which houses the great telescope does not lend itself to the same architectural possibilities, but nevertheless it harmonizes well with the Administration Building. The observatory stands on the highest ground in that vicinity, the ground floor of the great dome being about 800 feet above sea level. It is in the midst of an estate of 179 acres. This amount of land seems to many unnecessarily large, but there is a very important reason for having it. The large telescope will be used almost exclusively for photography and must not be interfered

with by any extraneous light. It is therefore essential to prevent too many buildings and houses being erected in close proximity to the observatory. The small village of Richmond Hill, about one mile to the north west, offers an objection to the site, but it is not serious because fully three-fourths of the work will be done with the telescope pointing south of the zenith and the lights from the village will not shine directly into the dome.

The land around the observatory is at present quite open, with a few trees and shrubs scattered here and there. It would be much better from an astronomical point of view if the land were more heavily wooded. It is intended to make the land into a park, to be known as the David Dunlap Park, and is very desirable to plant trees over the area as soon as possible. The reason for having the ground covered with a growth of trees is to shield it from the sun on the warm summer days. On an open plain the ground becomes quite hot during the day, and when, at sunset, this heat is given off again the warm air flowing upwards creates an unsteady atmosphere which interferes with the use of the telescope. The trees and vegetation absorb a great part of the sun's heat so that a steady state of the atmosphere is reached much more quickly. It is planned to have the site developed under the superintendence of the Department of Forestry of the University. Although the project of the observatory was started five years ago, this part of the scheme has been delayed by circumstances beyond our control. It should be carried out without delay.

Most of you however when you think of the observatory have in mind chiefly the large telescope which will be housed in the "Big Dome", and it is of it that I shall speak this evening. There will be smaller telescopes in the domes on the Administration Building capable of doing a great deal of good work. The small dome to the south will house the 19-inch reflector made some time ago in the University. The central dome will contain a 10-inch or a 12-inch visual refractor, and in the north dome will be mounted a photographic refractor. These subsidiary telescopes will be especially useful in an observatory so closely associated with instruction in the University.

The principle of the telescope was discovered about the year

The remainder of this address was the same as that at Montreal, for which see a previous page.

THE NEW YORK TIMES, SUNDAY, MARCH 4, 1934.

Casting a Giant Lens

The Tentative Model for the 200-Inch Telescope. Its Huge Size Is Indicated by the Figure at the Base. Above—Casting an Astronomical Mirror.

A SPACE-PIERCING EYE.

Wonders Involved in Making the Mightiest Telescope Glass.

AT Corning, N. Y., the mold is ready for the casting of a disk of glass 200 inches in diameter, which is to become the mirror or light-catcher of the greatest astronomical telescope ever constructed. Twice the diameter of the Carnegie Institution's famous 100-inch Mount Wilson reflector, this new instrument will be about ten times as effective. When it is done it will have entailed ten years of research and have cost $6,000,000, advanced by the International Education Board.

It might be supposed that size of mirror is a matter merely of a mold big enough. Astronomers know better. It was difficult to find a glass-maker who would undertake the casting of the 100-inch Mount Wilson mirror. Even then the block obtained was not perfect. In the case of the 200-inch mirror there have been practice castings, one of them yielding a disk of glass 120 inches in diameter.

The method of casting having been thus established, the stage is set for an event which is to take place this month and which is bound to arrest the attention of astronomers all over the world. Glass will run out of a furnace, a dazzling white-hot river, into a truck. Its temperature will be 1,500 degrees C. By the time the truck has reached the mold the temperature will have dropped to 1,000 degrees. Twenty tons of liquid will flow like water into the mold.

Then for four months the block will be allowed to cool. "Annealing," the technicians call this slow reduction of temperature. Its object is to avoid the strains which would be set up if the outer parts cooled quickly while the interior was still hot and soft. The strains would crack the mirror, just as a lamp chimney sometimes cracks for no apparent reason.

Clearing With Electrons.

Once cooled, the glass must be ground and polished to give it a slightly concave surface. The light of a star falls on every part of the surface, and from the surface it must be reflected to a focus, which is a mathematical point. If the grinders and polishers are wrong by a few millionths of an inch the image at the focus will be blurred. As the polishers proceed they do less work every day. Gradually the glass is heated by friction. Heat causes expansion. To polish the surface in that condition means that there can be no true focusing after contraction. So work is stopped and the disk covered for the day with a foot-thick layer of felt. When the covering is removed, twenty-four hours later, optical tests are made to find out where grinding and polishing are needed in order to obtain the final correct shape -what the mathematicians call a paraboloid of revolution.

Five years of work already lie behind those who have carried the project so far. Most of the preliminary research has been conducted by the physicists and astronomers of Mount Wilson Observatory of the Carnegie Institution of Washington for the California Institute of Technology to which the final installation will belong. Two years must be spent in grinding, surfacing and polishing the mirror. Then comes the difficult task of installation. It may be 1935 before we shall hear of the first revelations made by the mightiest astronomical eye ever devised.

Possible Revelations.

And what will these revelations be? Prediction is impossible. But if the triumphs that must be credited to the 100-inch mirror are any indication, we may expect a great visible addition to the 2,000,000 spiral nebulae, each a galaxy like our own; a piercing of space to greater depths and the discovery of systems undreamed of; a fine analysis of the spirals that whirl in such great agglomerations as the Great Nebula of Andromeda; a deeper understanding of the Milky Way and our own place in it; a verification or refutation of the theory that the universe is expanding; new light on Mars and its enigmatic "canals"; and a study of matter in the stars, at pressures of

billions of tons to the square inch and at temperatures measured in unthinkable millions of degrees, which will help to clarify some of the mysteries of matter.

London Times, Tue. Mar 27, 1934

WORLD'S LARGEST TELESCOPE

CONSTRUCTION IN NEW YORK

FROM OUR OWN CORRESPONDENT

NEW YORK, MARCH 26

Twenty tons of molten glass were poured yesterday into the mould of what will be by far the largest telescope mirror ever constructed. It was an anxious undertaking which took 10 hours to complete, but though there were some mishaps it is believed to have been successful. That, however, will not be known with certainty for another 10 months -so long will the mirror be allowed to cool in order to prevent cracking.

The mirror, which is to be 200 inches in diameter, is being made at the Corning Glass Works, Corning, New York, for the California Institute of Technology, and will be set up at the Mount Wilson Observatory, Pasadena.

When the pouring was half over yesterday some of the cores became detached and floated to the surface of the white-hot glass. The director of the work was confident, however, that these could be scooped out when pouring was finished without harming the mirror.

Among the 4,000 spectators of the work was a group of distinguished men of science, including Sir William Bragg, Dr. George Ellery Hale, Honorary Director of the Mount Wilson Observatory, Dr. W. S. Adams, Director of the Observatory, and Dr. C. A. Chant, of the Dunlap Observatory, Toronto.

The focal length of the mirror will be 55ft. It will gather four times as much light as the largest telescope now existing, and will make possible the photography of objects four times farther out in space than those which can now be photographed. Photographs will be taken 10 times faster than they can be taken now. A hint of the possibilities opened up by the telescope is afforded by the fact that astronomers will probably be able to photograph with it star clouds 12,000,000,000 light years distant. But a long time as human affairs go must pass before it will be set up and ready for use. Two years will be required after the mirror is taken from the mould and sent to California to grind it for the work it has to do.

* The largest telescope in existence at present is the 100in reflector at the Mount Wilson Observatory. Funds for the new instrument are being provided by the International Education Board, which administers Rockefeller benefactions.

THE TIMES
WEDNESDAY
MARCH 28 1934

THE LARGEST TELESCOPE

FROM OUR OWN CORRESPONDENT

NEW YORK, MARCH 27

It is feared that the 200in. telescope mirror, the largest in the world, now being made at Corning for the California Institute of Technology, will be found defective because of mishaps which occurred while the glass was being poured into the mould on Sunday. When some of the cores of the mould became detached, the iron bars which had held them in place melted. It will be six weeks before the glass has cooled sufficiently to examine it for defects. Meanwhile another mould will be made in case it is necessary to do the work all over again.

SCIENTISTS MEET TO WATCH LENS MADE

CORNING, N.Y., March 24.—(A.P.)—Distinguished scientists from all over the continent gathered today to see the creation of a cyclopean lens for the world's largest telescope.

Molten glass for a 200-inch lens will be poured tomorrow at the Corning Glass Works—an operation which has attracted the interest of the whole world of science.

Among those here for the event are Sir William Bragg, noted British scientist, and Dr. C. A. Chant, director of the Dunlap Observatory, Toronto.

Montreal Daily Star
March 24, 1934

MONDAY, The Daily Mail MARCH 26, 1934

MAKING THE WORLD'S BIGGEST MIRROR

FOR £1,200,000 TELESCOPE

MOLTEN GLASS OF 2,800 DEGREES

10 Months to Cool

From Our Own Correspondent

NEW YORK, Sunday.

ONE of the world's greatest experiments is in progress to-day at Corning, New York State, where 4,000 scientists from all parts of the world are gathered.

They are watching 20 tons of liquid glass being transformed into a mirror for the world's largest telescope.

The complete telescope is to cost £1,200,000, and the mirror will be 200in. in diameter, compared with the Mount Wilson Observatory telescope of 100in.

To-day's job is a major step in making the giant reflector. Glass is being poured from a furnace in which the temperature is 2,800deg. Fahrenheit.

The mould is already heated and can be cooled off only a few degrees a day, so that it will be ten months before the mirror is solid.

5 YEARS' PREPARATION

Dr. George McCauley, physicist in charge of the operation, is going without sleep for 48 hours until he is assured that the experiment is successful.

For five years astronomers and scientists in the glass industry have worked on the problem, yet many hearts are beating fast in the Corning glass works as the job proceeds.

The actual pouring occupies eight hours, the workers being provided with special clothing against the intense heat, but it has taken a month to heat the furnace to the required temperature.

The mirror being cast is not a solid cylinder of glass. Its back is honeycombed with holes arranged in geometrical patterns which make for lightness and a greater facility in use. It will have ten times the ability to gather light compared with its 100in brother.

Whether this new giant "eye" will solve the mystery of life on Mars is one of those fascinating questions which await an answer as the Corning glass men work on the lens.

TUESDAY, The Daily Mail MARCH 27, 1934.

200-INCH MIRROR'S BLINDING FLASHES

THRILLING SPECTACLE OF WHITE-HOT GLASS

CROWD SEIZE SOUVENIRS

MISHAP MAY MAR WORLD'S GREATEST TELESCOPE

From Our Own Correspondent

NEW YORK, Monday.

THE world's greatest experiment for prying into the secrets of the universe has been completed.

The giant mirror for the £1,200,000 telescope, which will be the largest in the world, is now in its mould—liquid glass that will take ten months to cool.

While 6,000 people, including Sir William Bragg, the scientist, who is now lecturing at Cornell University, filed through the Corning (New York State) Glass Works, an official of the company explained that

in the opinion of physicists the whole casting operation is one vast experiment, and not until the great disc is removed from the mould and in one piece, without evidence of any strain, will the success of the casting be known.

Yesterday's operation was not entirely successful. The mould contained geometrically arranged turrets or pylons across its floor, the object of which was to provide corresponding holes in the mirror to reduce its weight.

WHITE-HOT "SOUP"

Some of these turrets, which were clamped by iron bolts which melted in the intense heat of the furnaces, broke away and floated to the top of the liquid glass. They were fished out of the white-hot "soup" by workmen.

When the mirror is ready for use the places where the holes should have been will have to be drilled out with sand-blasting apparatus without cracking the mirror.

Visitors enjoyed the spectacle of the filling of the mould amid a terrific din and blinding flashes from the furnace fires.

Standing 50ft. from the furnace, with its 2,800 degrees of heat, was the mould, a giant dome-shaped fire-brick structure heated by blasts of white-hot gases.

Grimy, sweating workmen thrust iron ladles, each holding 400lb. of glass into the blinding furnace and guided them to the great mould.

The front man carried a wooden shield round his neck, which he held by means of a mouthpiece in front of his face. This protected him from the dangerous ultra-violet rays in the furnaces.

Streamers of glass which came from the ladle's "overflow" were seized as souvenirs by the spectators.

Scientists believe that such an experiment will never again be undertaken—first, because the giant telescope was conceived in the days when the United States was flush with money, and, secondly, because a 200in. mirror is regarded as the limit of possibility in this field.

Dr. Walter Adams, director of Mount Wilson Observatory, who watched the casting of the mirror, said that it will enable astronomers to explore 27 times as much space round our solar system as is now possible.

$6,000,000 Eye Sees Aeons Back

Toronto Men Witness 20-ton Mirror Cast

Corning, N.Y., March 26. A huge telescope, one the largest ever made and expected to reveal hitherto unexplored depths of the universe, cooled slowly here in the annealing mould in preparation for the final stages of a year's effort in optical experiments.

Twenty tons of molten borosilicate glass were poured yesterday into the giant mould. When finally finished it will be 200 inches in diameter, and 26 feet thick, and is to be fitted into a telescope [illegible]

It took [illegible] scientists and [illegible] of [illegible] to pour the glass. Dr. C. A. Chant, director of the Dunlap Observatory, Toronto, and Sir William Bragg, of Great Britain, [illegible] of Toronto represented a [illegible] manufacturers of large telescopes who [illegible] a 26-inch mirror made here last autumn for use in a Toronto observatory.

The Daily Mail
TUESDAY, MARCH 27, 1934.

The Giant Telescope

Scientists will regret the mishap yesterday in the casting of the reflector for the gigantic new telescope which is under construction in the United States. It is certain to delay the completion of the instrument, and **years may pass before it is at work.**

When it is brought into action, with a power ten times greater than that of the 100in telescope at present in use at Mount Wilson, it should solve many problems. One of the most interesting of these is **whether vegetation exists on the moon.** Within the last few years some observers have thought they detected changes in the crater known as Linné. Most astronomers, however, still remain sceptical.

Another problem to be settled is the tremendous one of the existence of **life on Mars.** The new telescope should reveal whether the so-called canals really exist and whether they show signs, as the late Professor Lowell believed, of the desperate efforts of a dying race to cope with a desert world.

No 1038.

Edging the Main Mirror, General View. The disc is being made perfectly circular and 76 inches in diameter. May 1934

No 1059

Edging the Main Mirror-View showing the Grinding Tool. The disc cotinually rotates. May 1934

Reprinted from "Engineering" (England) March 9, 30, and April 30, 1934

74-IN. REFLECTING TELESCOPE

FOR THE

DAVID DUNLAP MEMORIAL OBSERVATORY

OF

TORONTO UNIVERSITY,

CANADA.

SIR HOWARD GRUBB, PARSONS AND COMPANY,
OPTICAL WORKS
NEWCASTLE-UPON-TYNE, ENGLAND.
Proprietors, C. A. PARSONS AND COMPANY, LIMITED,
HEATON WORKS, NEWCASTLE-UPON-TYNE

Reprinted from
"ENGINEERING,"
March 9, 30, and April 20, 1934

LONDON
OFFICES OF "ENGINEERING", 35 and 36, BEDFORD STREET, STRAND, W.C.2.
1934.

Publication No 10

74-in. REFLECTING TELESCOPE FOR THE UNIVERSITY OF TORONTO.

Constructed by

Messrs. SIR HOWARD GRUBB, PARSONS and COMPANY, NEWCASTLE-UPON-TYNE.

It is pleasing to note that memorials to prominent men who have passed away, instead of taking the form of some ornate and useless structure, are now often intended to benefit a local community, or even the whole human race, by helping to extend existing knowledge in some particular branch of science. That made by the widow and son of Mr. David A. Dunlap, late of Toronto, Ont., is

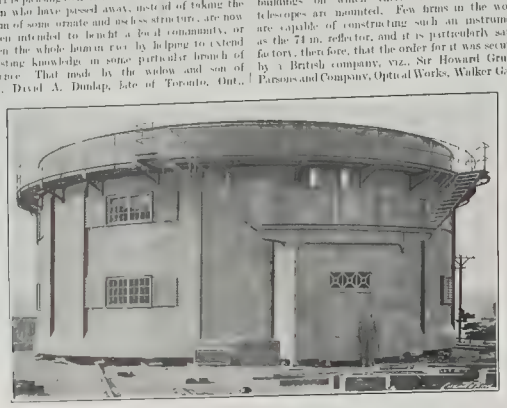


FIG. 1. OBSERVATORY BUILDING ERECTED BEFORE DISPATCH

[illegible] of the largest telescope in the British Empire and the largest in the world. This memorial is a reflecting telescope of [illegible] 74 in., which is similar to that at Mount Wilson, which has an aperture of 100 in., and when completed will be presented to the University of Toronto and administered by the Department of Astronomy of that University. It will be erected at a point 477 ft. above sea-level, on Richmond Hill, [illegible] about 9 miles north-east of the centre of the city of Toronto. In addition to the telescope itself, the site includes a block of administration buildings on which three domes for smaller telescopes are mounted. Few firms in the world are capable of constructing such an instrument as the 74 in. reflector, and it is particularly satisfactory, therefore, that the order for it was secured by a British company, viz., Sir Howard Grubb, Parsons and Company, Optical Works, Walker Gate, Newcastle upon Tyne, in face of both American and Continental competition. This firm, being associated with Messrs. C. A. Parsons and Company, Limited, is in a particularly fortunate position for the construction of large telescopes, since it has the use of Messrs. Parsons turbine shops for the accurate machining of heavy castings and other parts with which an optical works could not economically deal. The Optical Works are, however, fully equipped and staffed for the production of large mirrors and other optical parts, as well as for the light and heavy instrument work, of which so much is involved in the construction of a telescope of even moderate aperture. Work was commenced

on the Toronto telescope in November, 1930, and it was dispatched from the makers' works in September, 1933.

The instrument is housed in a cylindrical building, 61 ft. in diameter, sheathed inside and outside with steel sheeting and illustrated in Fig. 1 on page 1. The entrance is in the south side, through a steel porch with two pairs of doors, one pair of which can be seen in Fig. 1. The observing floor is 13 ft. above the ground level and a doorway leads from this floor to the top of the porch. From this, stairways give access to a gallery running right round the building at a height of 23 ft. above the ground level. A similar gallery inside the building gives access to a segmental platform in the revolving dome which covers the building. From the segmental platform the observer can reach an observing platform which is used when the telescope is employed as a Newtonian. A lift is provided inside the building for removing the cell and main mirror when the latter requires to be re-silvered.

Fig. 14, on page 8, shows the dome erected complete, except for the roofing material, in the yard of Messrs. The Cleveland Bridge and Engineering Company, Limited, Darlington, who constructed both the framework of the dome and the building to the designs of Messrs. Sir Howard Grubb, Parsons and Company. The dome is 61 ft. in outside diameter, and has a parallel opening 15 ft. wide, extending from the horizontal to a point 7 ft. beyond the zenith. Two parallel moving shutters running on rails at the top and bottom of the dome, as will be clear from Fig. 14, close the opening, these shutters being operated simultaneously by means of wire ropes connected to a motor-operated gear; emergency hand gear is also provided. Two motor-operated wind screens, of sail cloth, are mounted in the opening, one rising from the bottom and the other descending from the top, so as to close the opening except for that part through which the telescope is actually pointed.

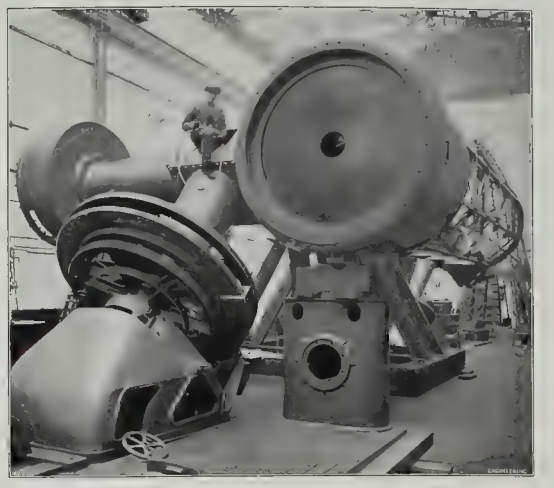
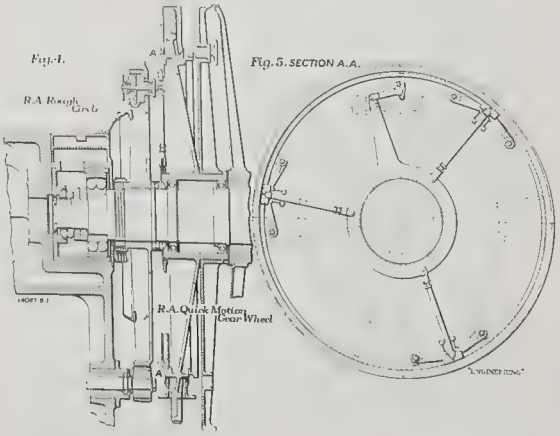


FIG. 2. TELESCOPE LOOKING FROM REAR OF CENTRE PIECE

The dome is carried on 24 canted rollers, 27 in. in diameter, mounted in self-aligning ball bearings and running on a flat-bottomed rail. This rail is mounted on a strong annular girder which is supported on 24 steel columns, each 21 ft. high. Lateral rollers, of which 16 pairs are fitted, run on the inner and outer edge of the rail to keep the dome in position. Two segmental platforms, one at the base of the opening and the other at the back,

[illegible] above the former, access outside the dome. It is mounted on the portal straight [illegible] of these platforms on which rests a bridge in the form of a square [illegible] bridge, which we [illegible] with more subsequent articles, is 5 ft. 6 in. [illegible] and is provided at each end, that on the right [illegible] with a slide shown on the [illegible] track, [illegible] this track carrying an observing platform, [illegible] the instrument as arranged as a Newtonian. The dome is rotated by means of a 7½ hp motor and gearing mounted near the floor, on the ground level. Rotation is effected by means of an endless steel rope passing almost round an annular channel carried on brackets fixed to the base of the dome, over two tangent pulleys, and down to the turning gear, a tension pulley being provided to keep the rope taut. The dome and building were dispatched in June, 1933.

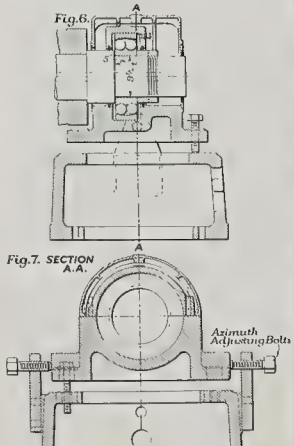
The general arrangement of the telescope can easily be followed by inspection of Fig. 2, page 2, Fig. 3, on Plate, Figs. 15 and 16 on page 9. Of these, Fig. 15 is a view of the instrument erected in the makers' shops before dispatch, this view being taken from the north-west, with the tube pointing south. Fig. 16 is a view from the south-east with the tube vertical, and Fig. 2 is a view from the back of the centre piece, with the mirror box removed, the tube lying horizontally. This view clearly shows the large



flat, set at an angle of 45 deg. with the axis, is fixed near the upper end of the tube, and this brings the light to a focus at a point outside the tube, where an eyepiece, or photographic camera, is mounted when required. A stellar spectrograph is being constructed by Messrs. Adam Hilger, Limited, London, for use with the telescope arranged as a Cassegrainian. It is of the single-prism type with a 24 in. collimator and two cameras of 12½ in. and 25 in. focus, respectively.

The polar axis complete with trestles ready for lifting into position in the erecting shop, is shown in Fig. 11. It will be recognised from the illustrations already referred to that the mounting is of the English or composite type, in which the tube is placed on one side of the polar axis and the counterpoise on the other. The design of the axis, which is 22 ft. in

length and weighs 9 tons, is, however, best shown in the general arrangement drawing, Fig. 3, on Plate, from which it will be seen that it is built up of two tapered tubular steel castings bolted to a central cubical steel box and having forged steel pivots shrunk into the ends. It turns in self-aligning radial ball bearings at each end, a ball thrust bearing being fitted at the lower end, which is housed in a cast-iron base casting, as clearly shown in Fig 3. The polar axis is, of course, set parallel with that of the earth, and the bearing at the upper, or north, end is carried on a concrete pedestal, as shown in Fig. 3. Details of the design of this bearing are given in Figs. 6 and 7, annexed, which show the arrangements provided for adjusting the position of the axis in the vertical and horizontal planes to secure accurate alignment.



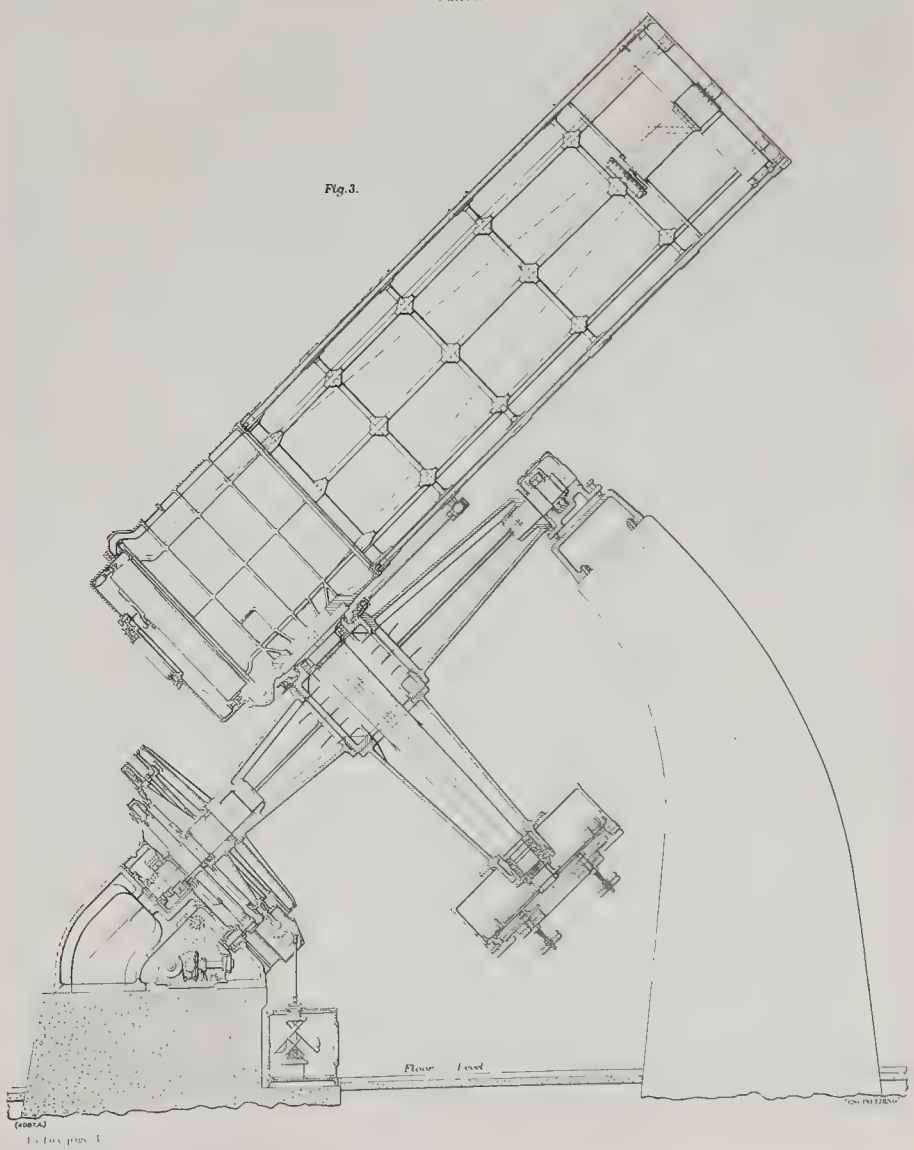
Longitudinal and transverse sections of the lower end of the polar axis, showing the right ascension clamping gear, are given in Figs. 4 and 5, respectively, on page 3. The actual driving circle, which is in the form of a worm wheel, is mounted free on the lower pivot of the axis on ball bearings, but it can be clamped rigidly to the quick-motion gear wheel, which is keyed to the axis, by means of a motor-operated clamping gear best shown in Fig. 5. It will be seen from this that when it is required to clamp the circle to the quick-motion gear wheel, and thus to the axis, a small motor mounted in the quick-motion gear wheel is set in motion, and this drives a small crank mechanism through worm reduction gearing. A connecting rod couples the crank to the radial arm extending from a floating central ring, to which are pivoted three rods, 120 deg. apart. The outer ends of these rods each bear on a pair of hinged shoes, which fit into a groove formed on a ring attached to the circle, as clearly shown in Fig. 4. The three rods, it may be pointed out, are not quite radial when the circle is unclamped, but the operation of the clamping motor, as explained above, turns them into the radial position and thus forces the shoes into the groove. When so clamped the axis can be driven by the clock, as will be explained later, but, when unclamped, the telescope can be turned about the polar axis at a comparatively high speed by means of a motor, and can also be adjusted by hand by the mechanism indicated by dotted lines in Fig. 3. We shall refer later to the quick motion in right ascension when dealing with that in declination.

The circle is a steel casting fitted with a bronze ring in which the teeth are cut, the ring being slightly shrunk on and fixed by a number of Delta metal screws. The pitch diameter is 8 ft., and 960 teeth of 8-mm. pitch were cut with the aid of a 4-ft. of 8-mm. pitch were cut with the aid of a 4-ft. diameter master circle, graduated on silver. On the extreme right of Fig. 4 is shown the sidereal circle, which is 8 ft. in diameter, and is mounted on the boss of the driving circle. It can easily be rotated by one of six handwheels provided, five of which are distinguishable in Fig. 15, page 9, while one is shown in section in Fig. 4, page 3. These handwheels are fitted with pinions which gear with a toothed ring on the driving circle, as will be clear on reference to Fig. 4. The sidereal circle is of welded steel construction and is fitted with a Delta metal rim 3 in. wide, graduated on both edges to 1 minute of time. The lower set of divisions read against indexes fixed to the guard of the driving circle and mark sidereal time, while the upper set of divisions read against indexes attached to the polar axis and mark right ascension. An hour-angle circle, clearly shown in Figs. 2 and 11 on page 2 and page 6, respectively, is fixed to the quick-motion gear wheel.

Coming now to the declination axis we may first refer to Fig. 8, on page 5, which shows a longitudinal section through the declination axis, with part of the polar axis on the left. The declination axis itself passes at right-angles through the cubical centre section of the polar axis and is supported at its outer end in a tubular tapered steel casting bolted on to the cubical portion of the polar axis. The declination axis is a forging 13 ft. in length, weighing 3½ tons, and formed, as shown in Fig. 8, with a flange at the inner end, 3 ft. 5 in. in diameter, to which the telescope tube is attached. The axis turns in ball radial bearings with a double-thrust bearing at the outer end. The quick-motion gear wheel is keyed on to the outer end of the axis

PLATE

Fig. 3.



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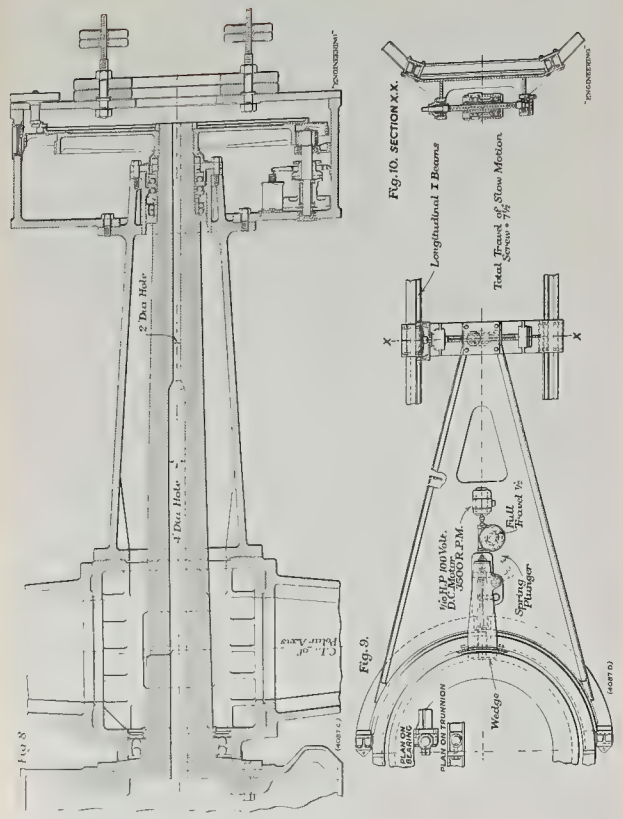

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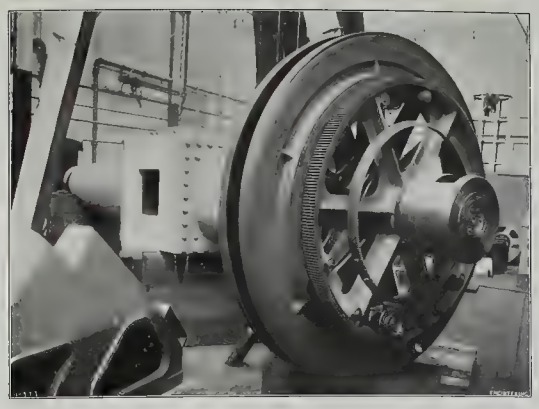

Fig. 11. Polar Axis Ready for Lifting.

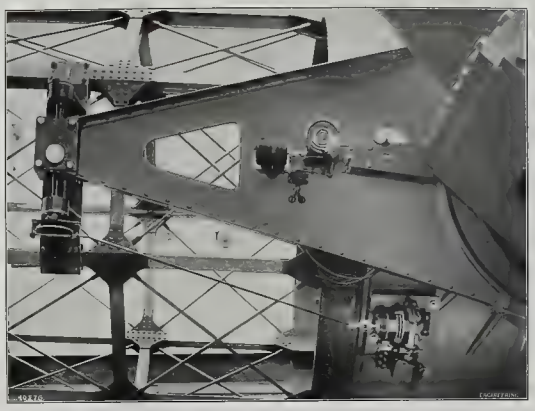

Fig. 12. Declination Clamp and Two-Speed Gear.

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as also is the declination circle, which is 6 ft. 3 in. in diameter and graduated to 1 degree of arc. The gear wheel and pinion, as will be seen from Fig. 8, is housed in a drum-shaped casting bolted to the end of the tubular support carrying the axis, this casting forming the counterpoise for the telescope tube. An interesting feature in connection with the declination gear is that it has been arranged to drive two drums, each 12 in. in diameter, the gear ratio being a step up of 1 : 72. There is no backlash in the drives and the drums are graduated with 60 divisions, each of which represents 5 min. of arc. One of these drums can be seen on the top right hand corner of Fig. 8, and a window, through

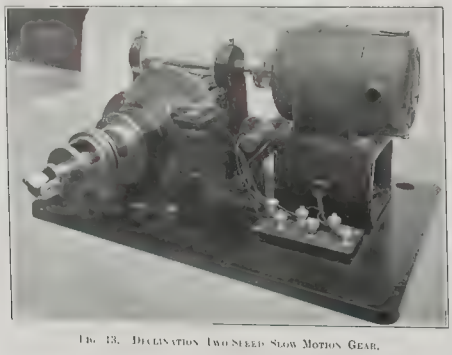

Fig. 13. Declination Two Speed Slow Motion Gear.

which the declination circle can be read directly, will also be noticed.

Both the right ascension and the declination quick motions are operated by reversible motors, that for the former being of 1¼ h.p. and that for the latter of ¾ h.p. They are both arranged to rotate the axes at the rate of one revolution in 8 min. The drives are taken through dog clutches operated by solenoids in parallel with the motor circuits, so that the motors and reduction gears are automatically disconnected from the telescope when not in use. A friction clutch is also incorporated, and the switchgear controlling the motor is arranged so that when the motors are switched off the dog clutches remain engaged for a few seconds, allowing the friction clutches to slip and thus bring the telescope gently to rest. The solenoid-operated dog clutch for the declination quick motion can be seen in Fig. 8, although the motor and friction clutch, which are, of course, housed in the drum-shaped casting, are not shown.

The declination clamp is located between the polar axis and the telescope tube, and is indicated in Fig. 3, although not shown in Fig. 8. Both the clamp and the slow-motion gear in declination are, however, clearly shown in Figs. 9 and 10, on page 5, and by the photograph reproduced in Fig. 12, on page 6. The clamp consists of a welded steel arm, about 7 ft. in length, mounted on a ring 4 ft. in diameter, attached to the side of the polar axis and having a Vee-groove in it. The arm can be rigidly clamped to the grooved ring by toggle gear operated by a small motor, as clearly shown in Figs. 9 and 12. The outer end of the arm is fitted with a nut mounted on a link motion, and engaging with a screw mounted in bearings attached to a bracket, which is firmly clamped to the side of the telescope tube. A motor, with a reduction gear giving two speeds, is connected to the screw by a universally jointed shaft, as shown in Fig. 12, and by this means the setting and guiding motion in declination are obtained. The motor and two-speed gear are shown separately in Fig. 13, on this page. The motor is controlled by two separate reversing switches. For the setting motion, a dog clutch, operated by a solenoid in parallel with the motor, connects the gear to the slow-motion screw and moves the telescope tube in declination at the rate of 15 min. of arc in one minute of time. For the guiding motion an electromagnet in parallel with the motor brings a differential gear into action, giving a rate of motion of 30 seconds of arc in one minute of time. Similar rates of motion are provided for setting and guiding in right ascension.

Before describing the optical system of the instrument, we may mention that the tube, best shown in Fig. 3, on Plate, is made in three

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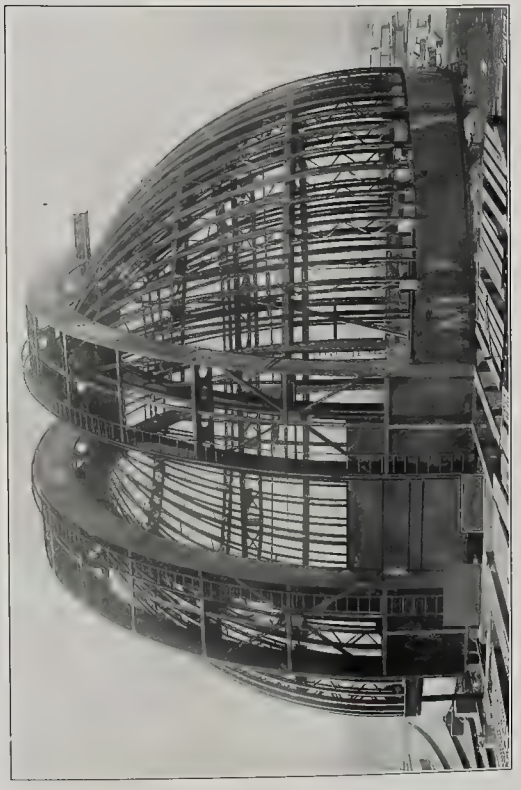


Fig. 14. Dome Erected in Makers' Yard.

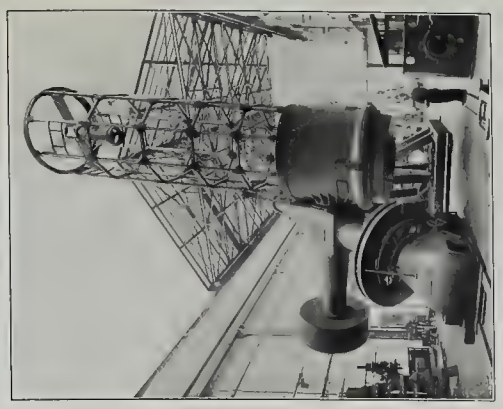


Fig. 16. Telescope from South-East Position.

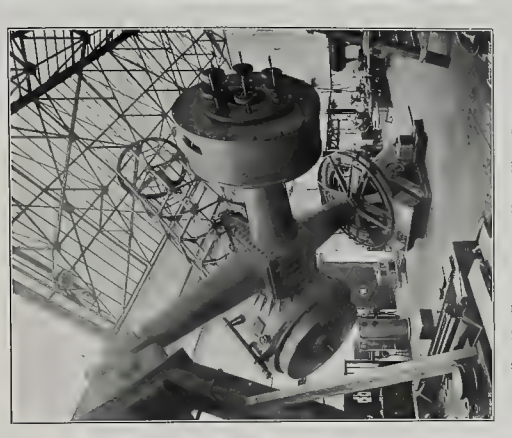


Fig. 15. Telescope from North-West Position.

sections, of which the lower section is the cell in which the main mirror is mounted. The central section is a steel casting, 7 ft in diameter, weighing 6 tons, and is formed with a large boss on one side to which the flange of the declination axis is bolted, as is most clearly shown in Fig. 8, on page 5. It will be seen, from Fig. 3, that just above the lower flange, to which the mirror cell is bolted, the casting is swelled out to 8 ft. 6 in. in diameter in order to accommodate the iris diaphragm; we shall describe the construction of this diaphragm later. The upper part of the tube is of skeleton construction and is octagonal in section. It is built up of I-sections of Duralumin connected by steel gusset plates, and braced with diagonal tension rods of Duralumin. The rods are screwed with right-hand and left-hand threads, and are tightened up so that they are always in tension in any position of the tube. The construction of the tube is shown in Figs. 15 and 16 on page 9.

Fig. 17.

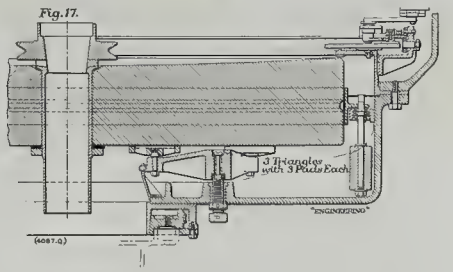


Fig. 18.

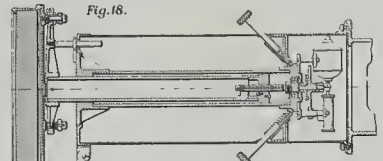
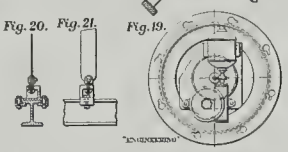


Fig. 20. Fig. 21. Fig. 19.



The latter showing the Cassegrainian mirror in position, but the details can be more readily followed from Figs. 22 and 23, on pages 11 and 12.

The main mirror cell, a half section of which is shown in Fig. 17, above, is a ribbed steel casting fitted with nine circular pads which support the back of the mirror, each carrying its proper portion of the load. The pads are mounted in groups of three, on spherical seatings carried by three triangles, which are themselves mounted on

ball bearings with spherical seatings. The latter are fitted on to screws, by means of which the mirror can be squared with the tube. For the lateral support of the mirror, when the tube is moved out of the vertical, 18 weighted levers, one of which is shown in Fig. 17, are provided. They are disposed round the inside of the cell and are mounted on universal joints. The short ends of the levers, as shown in Fig. 17, fit into holes in brackets riveted on to a flexible band, which is loosely clamped round the mirror. This band, it may be noted, has blocks fixed at intervals on its inner face, and these blocks fit loosely into a groove formed in the edge of the mirror, thus serving to keep the band central. The object of the large worm wheel fitted to the back of the cell, as shown in Fig. 17, is to carry the spectrograph, which is partly indicated by chain-dotted lines.

The iris diaphragm can be seen in section in the top right-hand corner of Fig. 17, and photographs of it before being fitted into the cell are reproduced in Figs. 25 and 26 on pages 13 and 14. The construction of the diaphragm is generally similar to that of the small diaphragms used in photographic cameras, but in order to prevent sagging of the leaves, owing to their considerable weight, and to keep the aperture central when the tube is near the horizontal position, it was found necessary to guide the moving ends of the leaves between bars having a radius equal to the length of the leaves. Only four of the 20 leaves are thus guided, the other leaves being connected to the guided leaves by links and levers visible in Figs. 25 and 26. Of these illustrations, the former shows the diaphragm at its maximum aperture of 74 m. and the latter at the minimum aperture of 12 m. The diaphragm is operated by a pinion and circular rack, the former being fitted with a handwheel which the man is holding in Fig. 25.

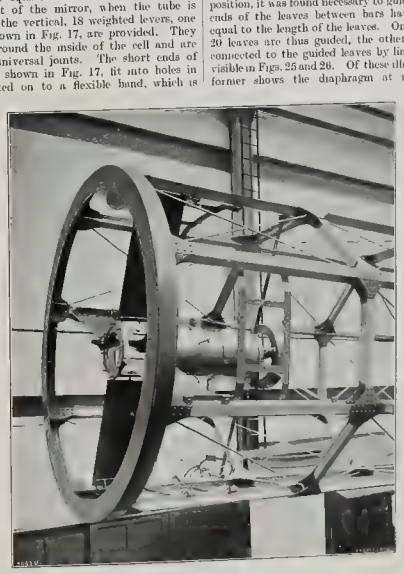


Fig. 22. Cassegrainian Mirror Mounting

Coming now to the optical system, we may mention that the main parabolic mirror is of a special Pyrex glass, the use for which was made in the United States, the disc being worked and figured by Messrs. Sir Howard Grubb, Parsons and Company; the focal length is 30 ft. The Cassegrainian and Newtonian mirrors are made of hard crown glass, and are 19 in. and 20 in. in diameter, respectively. The Cassegrainian mirror, which is convex and of hyperbolic form, is designed to give, with the main mirror, a focal length of 111 ft., so that the aperture is F/18. For mounting both these mirrors, a welded-steel box, of square section, with circular flanges, is suspended in the centre of the upper end of the tube on four strips of spring steel placed edgeways, so as to obstruct as little as possible of the light. These strips are clearly shown in Fig. 22, page 11, and Fig. 24, below. To this box, which is shown complete in Fig. 24, the mirror mounting is illustrated in Fig. 23, below, and Fig. 24, opposite. It should be mentioned, in connection with this, that the reflected beam can be directed to any one of four positions round the sides of the tube, where frames are fixed to which the photographic breech piece can be attached. In Fig. 24 the breech piece can be seen in position at the top of the illustration, and one of the three other frames to which it can also be attached is clearly shown in the centre of the illustration.

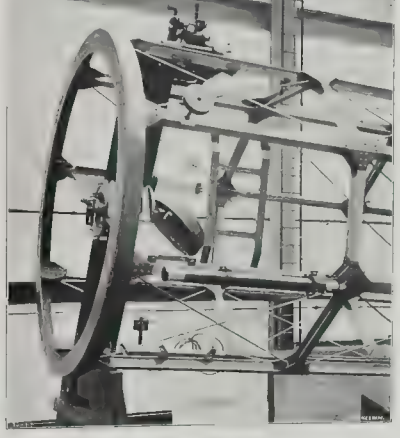


Fig. 23. Newtonian Gear in Position

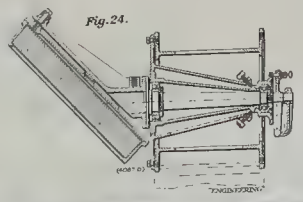
mountings for either the Cassegrainian or the Newtonian mirrors can be attached. Special gear has been supplied for handling these mountings and interchanging them conveniently and safely. The Cassegrainian mirror mounting is shown in detail in Figs. 18 to 21, on page 10, and is also illustrated in Fig. 22, page 11. Screws, using gear, operated by an electric motor, is provided, as shown in Figs. 18 and 19, and the former of these shows the sets of arms for adjusting the Cassegrainian mirror into exact parallelism with the main mirror. Figs. 20 and 21 illustrate the straining device for the spring steel straps which support the lower end of the mounting. The Newtonian

The breech piece itself is shown separately in Fig. 27, page 15. It comprises focussing gear and a plate holder with two guiding microscopes mounted on a saddle and operated by micrometer screws. Rotary motion is also fitted to correct for rotation of the field which sometimes occurs at altitudes, probably due to refraction. The plate holders take plates of quarter-plate size, and are interchangeable with a knife-edge focussing plate and with adapters for oculars.

Apart from the optical system, it will, we believe, be generally agreed that the most important part of a telescope is the driving mechanism. Its function is, of course, to turn the moving parts of

the instrument, in this case weighing about 35 tons, about the polar axis, to compensate for the rotation of the earth. When the telescope is being used for long exposure photography, extreme accuracy of drive is required, otherwise the star images would be drawn out into lines on the photographic plate.

Fig. 24.



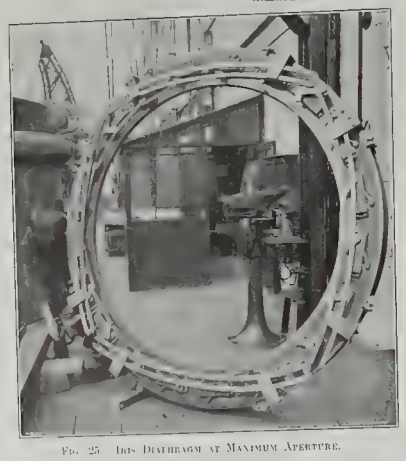


Fig. 25. Iris Diaphragm at Maximum Aperture.

Dr. R. K. Young, President of the Royal Astronomical Society of Canada, has aptly illustrated this problem as follows: A drift of the image of a star equal to half a inch during the course of an exposure, if the telescope is being used for photographic work, would be quite sufficient to destroy the plate. The engineering difficulties confronting the telescope maker in thus keeping the tube so accurately pointed are about equivalent to keeping a gun pointed on a target an inch in diameter at a range of twenty miles while the target is moving at the rate of 5 ft. per second."* The motion, moreover, must be continuous and without any trace of jerkiness. These arduous requirements are met by means of an electrically-driven clock and supplementary mechanism, which is corrected by a

* *The Reflecting Telescope for the David Dunlap Observatory.* Paper read before the Engineering Institute of Canada, Montreal, February 9, 1934, by R. K. Young, Ph.D.

very accurate seconds pendulum forming part of the equipment of all astronomical observatories.

A general view of the driving clock of the Toronto telescope is given in Fig. 28, on page 16, and a drawing of the mechanism is reproduced in Fig. 29. It comprises a heavy crossed-arm nearly isochronous governor driven indirectly by a ½-h.p. electric motor through a differential gear-box, shown in section in Fig. 29. A weight suspended from a chain passing over a pulley and attached to the outside of the

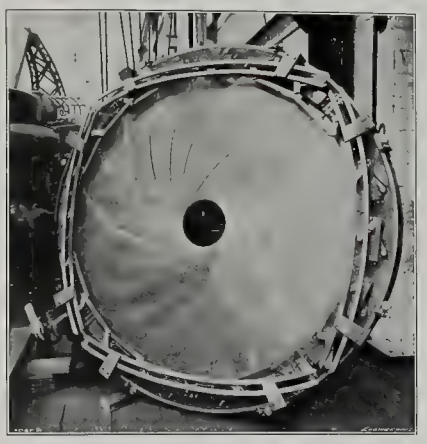


Fig. 26. Iris Diaphragm at Minimum Aperture.

differential gear-box, in the form of a Huyghen's loop, gives a constant driving force to the governor, and the gear-box carries an arm with a contact at its outer end, which passes over a number of studs arranged concentrically, and connected to resistances in the field circuit of the driving motor. When the motor is running at the correct speed, the weight is kept floating, but if the speed alters, the gear-box rotates, together with the contact arm, which then corrects the speed of the motor by altering the field resistance. The governor runs at 90 r.p.m., and is directly coupled by a vertical shaft, shown near the bottom of Fig. 3, on Plate, to a worm gearing with a worm wheel mounted on the lower of the two shafts shown in Fig. 30, on page 17. The worm and worm wheel are shown at the right hand end of this shaft, the worm being protected by a casing seen in the figure. The lower shaft, on which the correcting devices are fitted, as will be explained later, drives through spur gearing a second shaft, including a section on which an accurately-cut worm is formed, this worm engaging with an equally accurate worm wheel, called the driving circle, and mounted on the polar axis. The two shafts and the plate on which they are mounted are known as the gear plate.

Coming now to the correcting mechanism, we must first explain that the lower shaft, or jack shaft, is made in five parts, of which the first part reading from left to right in Fig. 30, carries the pinion driving the upper shaft, and this and the next two sections are connected together through epicyclic-differential gearing. The third, fourth and fifth sections are also connected through epicyclic-differential gearing, both sets of gearing being clearly shown in Fig. 30. On the centre section of the shaft is mounted, friction tight, a disc having 24 notches on the periphery, and opposite this disc is an electro-magnet connected to the observatory seconds pendulum. This magnet, which is thus energised once per second, is provided with an armature of special shape, and this enters each of the notches in the disc, which is intended to make one revolution in 24 seconds. When the speed is correct, the

entry of the armature into the notches has no effect, but if it should be fast or slow the disc is turned one way or the other relatively to the jack shaft. This relative motion operates a trigger connected to a spindle which passes longitudinally through the shaft and lifts a two-way mercury switch at the right hand end of the jack shaft; the connections to this switch are visible in Fig. 30. The effect of lifting this switch is to energise one of two electromagnets, the armatures of which are arranged to hold one of the discs carrying the planet wheels of the epicyclic differential gear, and in this way the jack shaft is slowed down or speeded up, as required. The second epicyclic differential gear, viz., that on the left in Fig. 30, is controlled by hand and is used for correcting errors due to refraction. It may be of interest to compare this gear plate with that for the reflector for Edinburgh, which was described on page 432 of our 128th volume (1929). If this comparison be made it will be seen that the two-way mercury switch takes the place of a considerable number of sliding and other contacts. The new gear, it may be mentioned, has only been fitted to the Toronto instrument and to a 36-in reflector recently erected at Greenwich.

As already explained, the Toronto telescope can be used both as a Cassegrainian and Newtonian, and since with the latter optical system the observer must be located near the upper end of the tube, a specially-designed bridge, carrying an adjustable observing platform, has been provided for this purpose. The bridge, which is in the form of a semi-arc, runs on rails mounted on the edges of two segmental platforms fixed inside the dome, as mentioned earlier. A photograph of the lower portion of the bridge, after erection in the makers'

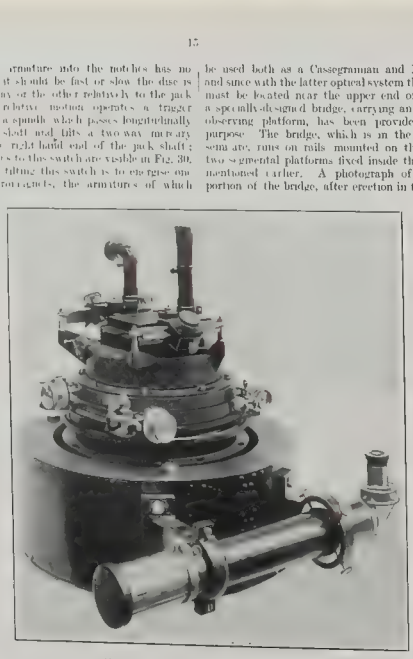


Fig. 27. Newtonian Bedplate.

shops, is reproduced in Fig. 34, on page 19, and details of its construction are illustrated in Figs. 31 to 33, on page 18. The horizontal distance between the running rails is 30 ft., and the difference of level between them is 16 ft. As already mentioned, the width of the bridge is 5 ft. 6 in., and this is about equally divided into a stairway and a track on which the observing platform runs. In the plan, Fig. 31, the method of driving the travelling wheels by a reversible motor through reduction gearing is shown dotted, and it will be noticed that power is transmitted to the lower travelling wheels through a long chain running over guide pulleys.

The observing platform is mounted on a four-wheel trolley, the wheels of which run on the upper

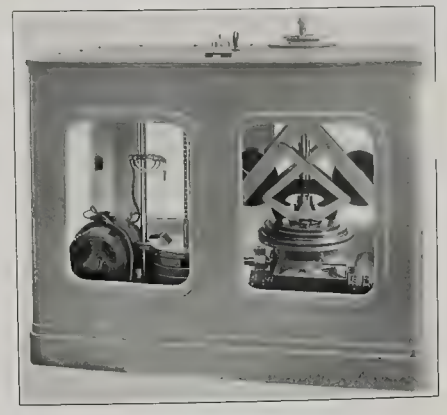
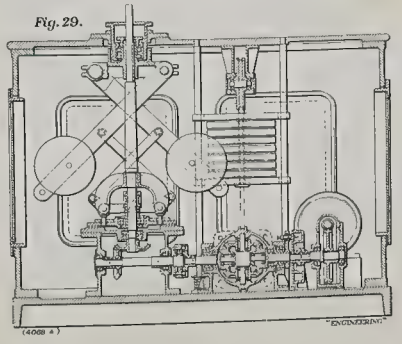


Fig. 28. Driving Clock.

Fig. 29.



flange of a pair of channels riveted to the side plates of the bridge. The trolley is held down by four wheels which run on the under surface of the upper flange, as is clearly shown in Fig. 33. The trolley is pulled up and down the bridge by wire ropes passing round an electrically-operated winch located on the upper end, as is best shown in the plan, Fig. 31. A smaller drum on this winch is used for a balance weight, which is shown dotted in its lowest position, and also half-way down, in the elevation, Fig. 32. The trolley on which the balance weight is mounted is shown in the plan, Fig. 31, and also in the transverse section, Fig. 33. It will be obvious that it is necessary to take steps to keep the observing platform level irrespective of

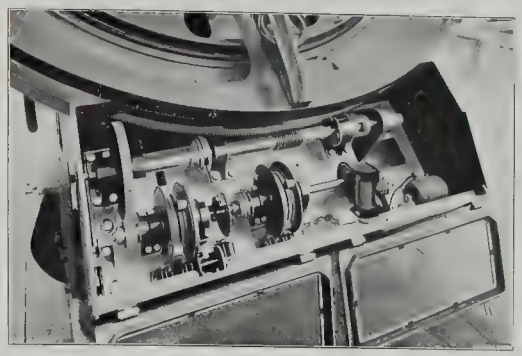


Fig. 30. Gear Plate with Cover Removed

its position on the bridge, and this is effected by mounting the platform on a short pedestal hinged to the upper part of the trolley, as is perhaps most clearly shown in Fig. 32. From the hinged pedestal extends an arm carrying at its outer end a small three-wheeled trolley which runs on a curved Tee iron attached to one of the web plates of the bridge. The curve of the Tee-iron is such that the observing platform is turned about a horizontal axis as it moves up and down the bridge, just sufficiently to keep it horizontal. The platform can also be turned about a vertical axis, a ball race being provided for this purpose in the upper part of the pedestal, as shown in Fig. 33. To move the platform round the observer turns the handwheel shown in Fig. 33, and a pinion on the lower end of the shaft on which the handwheel is mounted engages with a fixed gear cut on the periphery of the ball race. The platform can thus turn about a vertical axis, and move up and down the bridge, and the latter can be moved laterally in each direction. With these three movements the observer can obtain a convenient position near the Newtonian gear in practically any position of the telescope. There are two finders at the upper end of the telescope, one of 2½ in. and the other of 2-in. aperture. A third finder, of 4½-in aperture, and with the eyepiece mounted on cross slides, is provided at the lower end.

To the brief reference to the mirror mentioned earlier, we may now add that the mirror disc, which has been supplied by the Corning Glass Works, New York, is made of a special Pyrex glass, having a coefficient of expansion on the Centigrade scale of about 2·6 10⁻⁶, the corresponding figure for ordinary Pyrex glass being 3·2 10⁻⁶. It was cast face downwards with a concave face of nearly the required curve, and also with the central hole moulded in. The disc reached the Walker Gate Works in November last, its weight being 2 tons 6 cwt. The disc, as received, was a full 14 in. in thickness, and as the mirror cell would only accommodate a thickness of 12 in., 2 in. had to be ground off the back. This has now been done and the back polished. At present the edge is being ground true, and the next operation will be to grind the central hole true. The concave surface has already been rough ground to approximately the right curve, but the final polishing and figuring will occupy some months. It is expected that the mirror will be completed by the autumn.

For grinding and polishing this mirror the machine illustrated in Fig. 35, page 20, was constructed by Messrs. Sir Howard Grubb, Parsons and Company. The table can take a disc up to 90 in. in diameter, but apart from its size its special feature is that the table can be tilted to the vertical position; it is shown tilted to about 45 deg. in Fig. 35. The machine is erected in a room provided with automatic temperature control, and located at one end of a long testing gallery. It is thus possible, by

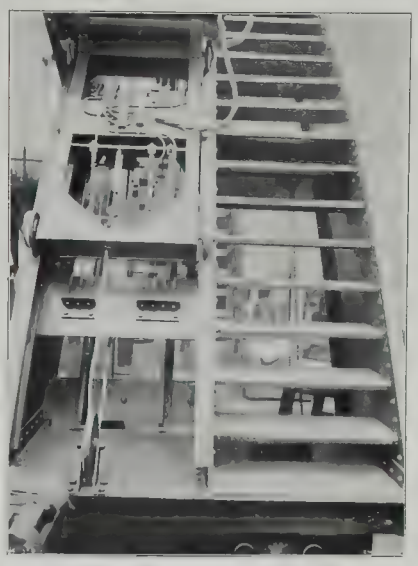


Fig. 34. Lower Part of Bridge for Observing Platform

tilting the table into the vertical position, to test the mirror without removing it from the machine. Many tests have to be made during the grinding and polishing operations, particularly when the final parabola form is being produced, and the fact that these tests can be carried out without removing the mirror from the machine saves much time and trouble, and also avoids the risks attendant on handling such a heavy but fragile object.

In conclusion, a few brief notes on the erection of the main parts of the telescope in Canada may be of interest. The circular building and dome, weighing nearly 200 tons, reached the site at the end of July, 1933, having been shipped directly to Toronto Harbour, and brought thence by road. The telescope, of which the total weight is about 50 tons, was shipped to Montreal, and was brought to Toronto by rail. From Toronto to the site the instrument was transported by road. Both the building and the telescope were erected by the Dominion Bridge Company, of Toronto, the work being supervised by the foreman of the makers erecting shop. The polar-axis assembly weighed 16½ tons, and a 20-ton Crane with a jib 32 ft. in length was erected to handle it. First the housings of the bearings were put in place on the north and south piers, shown in Fig. 3, on Plate. The driving and other circles were put in place on the south end of the axis and the axis was then lifted by the 20-ton

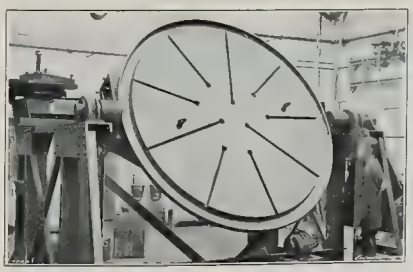
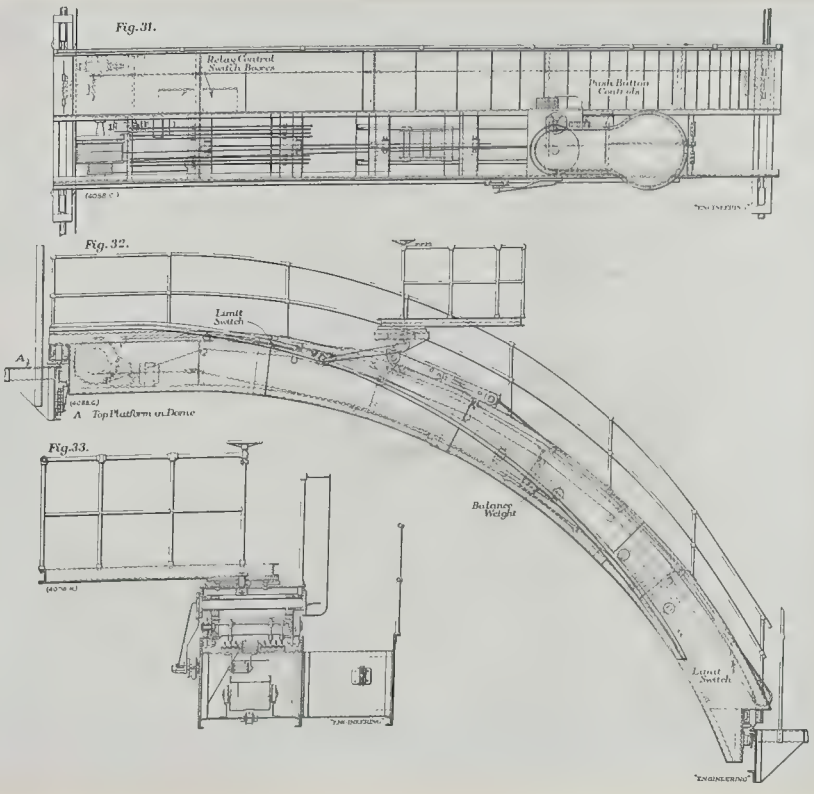


Fig. 35. Grinding Machine with Table Tilted

crane. When clear of the ground a second crane lifted the northern end of the axis until the latter was tilted to about 44 deg., which is the latitude of the site. The southern end was lashed to the hook of the main crane, so that the inclination of the axis could be maintained without the assistance of the second crane. The main crane then lifted the axis at the correct inclination, and passed it into the observatory building through the opening in the dome, afterwards gently lowering it into position in the bearings. The whole of this operation, we understand, occupied less than an hour. The declination sleeve, weighing 3 tons, was raised into position and bolted on to the cubical portion of the polar axis. After which the declination axis itself was lifted and put into position. The erection of the mirror cell, tube and other details presented no particular difficulty, and the instrument now awaits the arrival of the spectrograph and the mirror, of which the latter, as already stated, will be completed towards the end of this year. As already mentioned, the observatory, including the 74-in. telescope, will be administered by the Department of Astronomy of the University of Toronto, and doubtless good use will be made of this magnificent instrument.

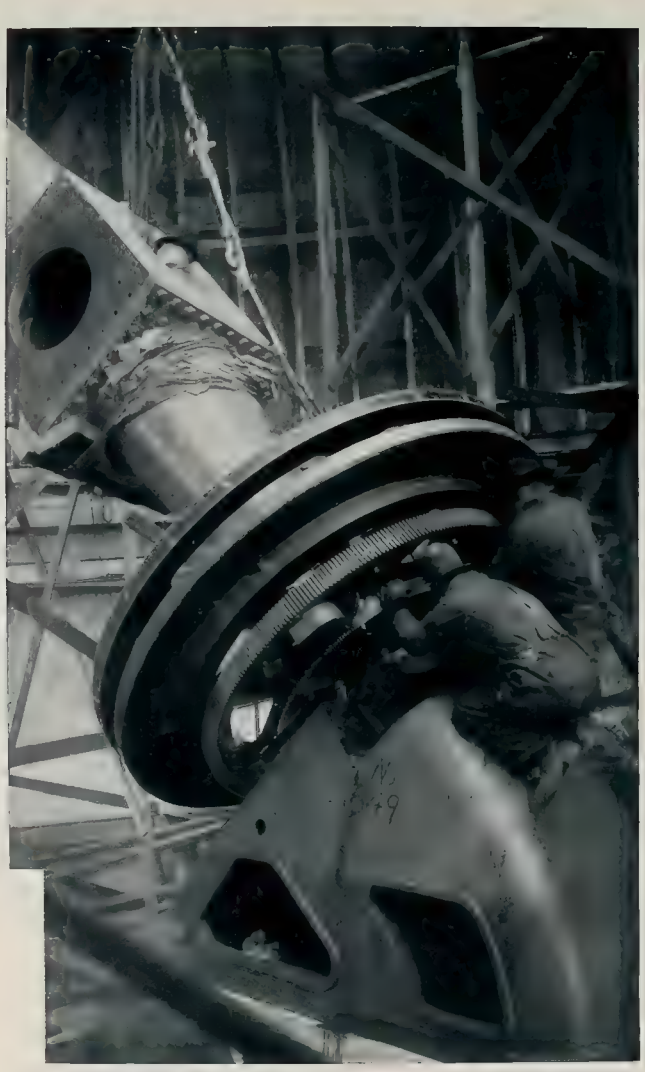


TWO GIANT TELESCOPES

April 21st. 1934

THE NEW 28-IN. REFLECTING TELESCOPE AT THE ROYAL OBSERVATORY, GREENWICH, which, together with the spacious building in which it is housed, has been presented by Mr. William Johnston Yapp in recognition of the work of Sir Frank Dyson as Astronomer Royal. In this picture the observer is seen using the cooling fan to escape with which he is able to correct small errors in the larger, clockwork-actuated instrument.

The set-backs of the new Greenwich telescope have been specially taken for THE SPHERE *by William Davis, and A. Cousins, and are reproduced here by courtesy of Dr. H. Spencer Jones, the Astronomer Royal.*



THE SECOND LARGEST IN THE WORLD. The new David Dunlap Memorial telescope now being erected at Richmond Hill, near Toronto, Canada. (A full description of this instrument appears below.)

It comes as a surprise to discover in Canada, this new country, in an isolated spot aloof on a hill top in the midst of a pasture field, a magnificent telescope, the finest in the British Empire—finer far than anything in England, exceeded, indeed, by only one other in the world, that on Mount Wilson, California. Yet this is what one finds to-day on Richmond Hill, fifteen miles north of Toronto, as he motors north on Yonge Street, that great artery of traffic which John Graves Simcoe, Canada's first Governor, cut through the bush, and which leads direct from the Queen City to that modern Aladdin's Cave, the rich mining region of Northern Ontario. The new David Dunlap Memorial telescope, which has been under construction for the last three years, is nearing completion. The administration building, of cut stone, is practically finished. The steel dome, 61 ft. in diameter, complete to the last word in equipment, which houses the telescope, is finished. The tube itself is installed. And the grinding of the great mirror, a long job, at must be correct to one-millionth of an inch—which has been in progress for many months, is well advanced. The opening event is scheduled for this autumn.

An interesting but odd-looking affair, this telescope. With its mighty muzzle pointing to heaven—the tube is 30 ft. in length, nearly 7 ft. in diameter, and wide open at the top—at first sight it suggests a huge trench mortar, ready with a bomb in its throat to belch forth death and destruction on the beautiful city lying below. But this iron tube harbours no menace, far otherwise. In the very bottom of it lies the great mirror, face up, reflecting a circle of sky, jewel-like in its almost impossible beauty. It is about this costly treasure of a mirror that all the delicate machinery and expensive plant of this, the world's newest observatory, centres.

The mirror of the new telescope is 74 in. in width and nearly a foot in thickness. It is of Pyrex glass, a type of glass with a high silica content. Observations with a telescope must always be made through

(Continued on p. 124.)

TWO GIANT TELESCOPES

(Continued from p. 105)

the widely opened shutter of the dome Canada, for part of the year at least, is a cold country; and while temperatures in the dome of an observatory are kept as nearly as possible on a par with those of the outer air, there is usually a difference. As the temperature to which it is exposed rises or falls, the mirror must respond. The small expansion or contraction of this type of glass means that a mirror made of it undergoes less change of figure and therefore gives more sharply defined images It is a vitally important matter in all classes of astronomic work, but more especially in the study of the extremely faint stars in the spiral nebulæ. The mirror is ground concave to a paraboloidal curve—a curve which differs somewhat from that of a sphere in that it focuses all the light rays at one point

The polar axis of the David Dunlap Memorial telescope is 22 ft in length and weighs 9 tons. It is supported at each end on masonry piers Except that it revolves on its bearings like a great spindle, in slow stately motion, it does not vary its position The declination axis, on the other hand, moves freely. It is the work-a-day axis of the telescope, on which the heavy tube turns when it is being depressed or elevated into position. This axis, of forged steel, is 13 ft. in length It pierces the polar axis through its centre section crosswise, an end projecting at right angles on each side. To one of these ends the tube of the telescope is securely bolted, and on the other end is loaded the counterpoise weight, a heavy, drum-shaped casting. Where the telescope is thus mounted—on one side of the polar axis, with a counterpoise on the other—the mounting is spoken of as the modified "English" or "Composite" type of mounting.

The tube of the telescope is not altogether unlike a cylinder—a something resembling a great pipe on end or a section of smoke-stack, only the lower portion of it is enclosed. In the very bottom is fitted a ribbed steel casting which forms the mirror cell. Above this, in a swelled-out section, is lodged the iris diaphragm, a huge camera shutter, with a spread of from 12 to 74 in The middle section is a steel casting, very massive, supplied on one side with a large boss for attachment to a flange on the end of the declination axis. All the upper part of the tube is of skeleton construction. Within this, at the top, is the mounting for the supplementary mirrors. Underneath all, at the bottom, is the fitting for the stellar spectroscope (supplied by Messrs Adam Hilger, Ltd.).

The seeing part of the human eye is very small. "How minute are our instruments, in comparison with the Celestial Universe!" once exclaimed El Karakat, an Arabian astronomer, who built a great observatory in Cairo in the twelfth century. He could see about 3,000 stars. Newton's little telescope increased this a hundredfold, making visible about 300,000 stars (taking the sky as a whole) Canada's new telescope will have about 100,000 eye power, and will bring into vision more than 1,000,000,000 stars, and thousands of those island universes which are so occupying the attention of astronomers to-day The moon, when it comes up over the Richmond Hill next September, will look as though distant only about fifty miles if the man in the moon lives in a house the same size as ours and we can put on just the exact spot we shall be able to see it Mars, the nearest of the planets, is now about 55,000,000 miles distant. Last spring it was little more than half that distance away Five years from now it will be much less than that, only about 20,000,000 miles distant, which, astronomically speaking, is very close indeed

By that time the students of the skies will probably have come to some pretty definite conclusions about this interesting neighbour—as to whether it is inhabited by men, about those great canals (?), the snow caps, the arid plains, the fertile sea bottoms, and whether life there, if there is any, corresponds to that on our earth We'll be mightily interested An object on Mars, to be seen here, would have to be pretty large, of course—at least thirty miles across Regarding stars, the nearest of these, aside from our sun, is so very far away—a million times as far away as Mars—that we cannot hope for much in the way of intimate detail beyond what we already have, which is a fair idea of its size, weight, and composition. But nobody knows what is in store exactly for the great new David Dunlap Memorial telescope, except that it will be a marvel It will penetrate 140,000,000 light-years into space. How far is that? Light travels 186,000 miles per second Nobody can comprehend it.

There is, of course, a story behind the building of this great telescope, as there is behind nearly every one of the great telescopes of America. The David Dunlap Memorial telescope is the fruit of a suggestion by Professor C A Chant, M A, Ph D, chief of the Department of Astronomy of Toronto University to Jessie D Dunlap and David Moffat Dunlap, the widow and the son, respectively, of the late David Dunlap, a prominent mining lawyer of Toronto, who during his lifetime was an enthusiastic student of the stars This munificent gift places Canada in the position of having two telescopes of the largest class.

ONWARD APRIL 21, 1934

Canada's Place in the Stars

By G. H. Mosher

THE University of Toronto has a new observatory, located on a height of land near Richmond Hill, a few miles north of the city. It is an impressive structure, with its grey stone walls and its four domes, and its setting of shrubbery and low trees, when you glimpse it from the near-by motor road of North Yonge Street. It makes you sit up and say sharply, "What place is that?"

It is the finest astronomical observatory in Canada, and, in Toronto U's opinion, long overdue. For years Toronto's telescopic equipment, consisting of one twelve-inch instrument and several smaller, portable ones, has been obsolete The great observatory

Workmen Adjusting the Giant Telescope

at Victoria, B.C., with its monster seventy-two-inch super telescope, had caused Toronto University's astronomy students to turn jealous eyes westward.

Mrs David A Dunlap, widow of a wealthy man whose hobby had been astronomy, donated most of what it took to construct the new "Star Battery" at Aurora and it took plenty of money!

Professor C A Chant, distinguished member of the Toronto University faculty and dean of Canadian astronomers, had been patiently putting up with inadequate equipment for a long time Now he is happy because he has moved into his new home You have to call it that for men like him spend more time in their "office" than they do in their own homes.

The David Dunlap Memorial observatory positively bristles with telescopes. Upon the main, or Administrative building there are three domes, a large, central one flanked by two smaller ones. Mounted in the central dome is a battery of three astronomical cameras used for photographing phenomenal happenings in the heavens, such as eclipses and showers of meteors Incidentally, speaking of eclipses, by the time the next total eclipse of the sun occurs in the Toronto vicinity the Dunlap Observatory will be over two hundred years old, an ancient landmark, and you and I will be ancestors

The smaller domes contain, respectively, a ten-inch "refractor" telescope for the use of the general public, and a nineteen inch "reflector" telescope, made by Professor R. K. Young, assistant to Professor Chant Although the observatory is at least fifteen miles from the Toronto waterfront if one of these telescopes were turned in that direction it would be possible to see a man painting the funnel of a boat at dock, and you could even see what color paint he was using. These two telescopes are, however, only "small potatoes" when compared to the show-piece of the observatory contained in the second building

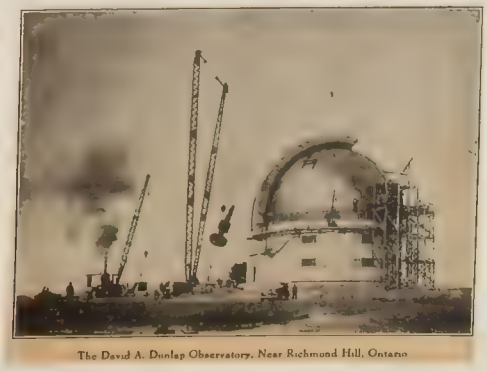
The second building is a steel dome built alone rugged lines, for it must support the giant telescope, sixty tons in weight, almost as heavy as a railway locomotive Two curved steel doors open and shut upon the aperture through which the telescope peeps They operate upon tracks built around the base of the dome The telescope poking its snout out into the night through this aperture, looks not unlike a long-range gun

Fifteen electric motors and innumerable pieces of clockwork mechanism combine in the effort to direct the monster spy glass toward the spot in the heavens the astronomers desire to investigate The telescope is set in a base of mercury to insure greater ease in swivelling

The mirror lens of this telescope is seventy-four inches across, just two inches larger than the one at Victoria It was ground to shape a concave hollow, by the firm of Sir Howard Grubb, Parsons & Company, of Newcastle-on-Tyne England The grinding job took three years You have to place your order well in advance when you want one of these things Telescope and dome cost $500,000 and they are considered to be worth every cent of it because of the exceptionally skilled labor involved and the fine quality of material used

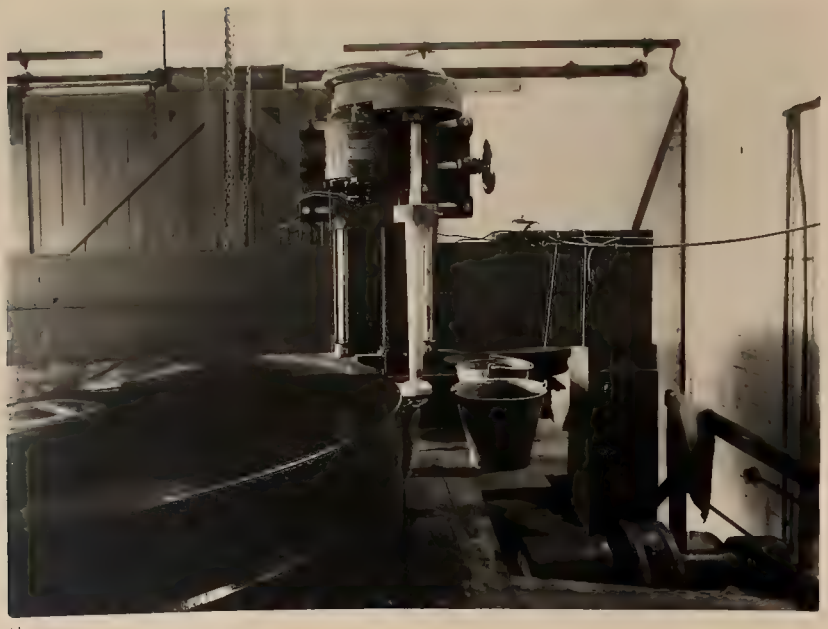
Although the science of astronomy began in Europe with the construction of the first telescope by the Italian, Galileo, in 1609, and Europe subsequently saw the passage of many great astronomers America now possesses the three largest telescopes in the world at Victoria, B.C., at Toronto and at Mount Wilson, California There the greatest telescope known to man peeps nightly through its dome on the steep wind-swept side of one of the High Sierras Its bias is eight feet four inches across

Occasional newspaper reports advise one that Professor Ritchie the man who constructed the present Mount Wilson telescope is at work upon another instrument which will be exactly twice its size When he finishes it as the saying goes We shall see what we shall see!



The David A. Dunlap Observatory, Near Richmond Hill, Ontario

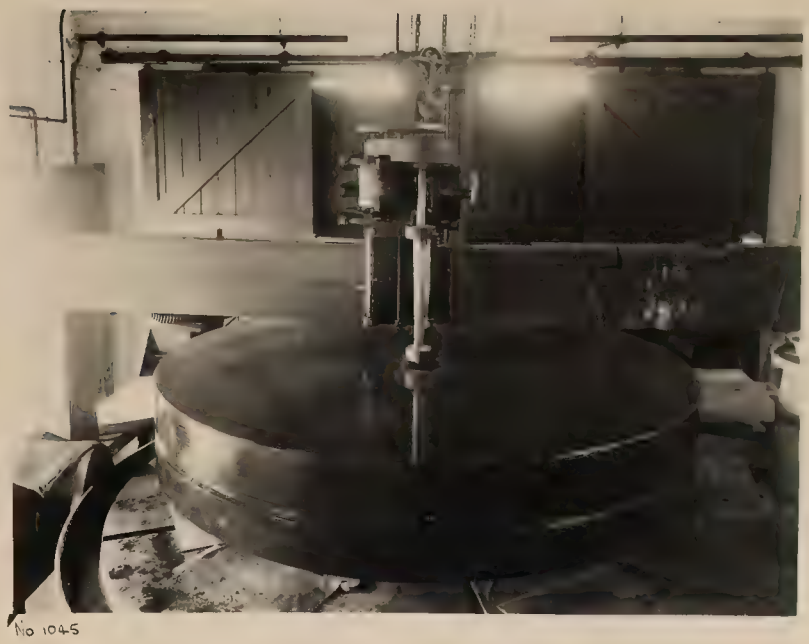
Two Views of the Great Mirror - May 1934



Bevelling the edge of the Disc 76 inches in Diameter.

Grinding the Groove in the Circumference.

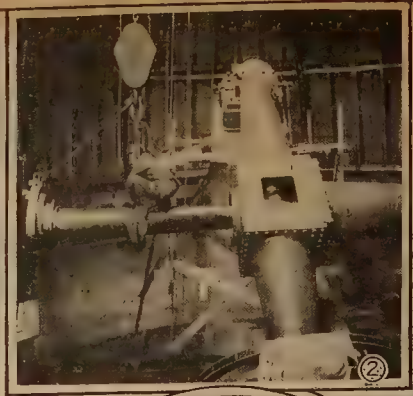
Two Views of the Great Mirror - May 1934



Grinding out the Central Hole.

Grinding out the Central Hole.

THE TORONTO DAILY STAR, TUESDAY, MAY 8, 1934



NEW DUNLAP MEMORIAL OBSERVATORY AT RICHMOND HILL NEARS COMPLETION

The new Dunlap Memorial Observatory at Richmond Hill, which has been under construction for the past three years, is now nearing completion. The administration building, of cut stone, is practically finished. The steel dome, 61 feet in diameter, which houses the telescope, is finished. The tube itself is installed. The grinding of the great mirror is well advanced. Photos show: (1) The new 36-inch reflecting telescope at the Royal Observatory, Greenwich; (2) a view of the interior of the dome of the Dunlap Memorial, showing the massive polar axis of the telescope. The axis is 22 feet in length and weighs nine tons. (3) The steel dome of the observatory, showing the declination axis being hoisted within. (4) The tremendous axis itself.

MOON BUT 50 MILES AWAY THROUGH GIANT TELESCOPE

Richmond Hill Instrument Second Most Powerful In the World

FINISHED SHORTLY

The new David Dunlap Memorial tele[scope] of Richmond Hill is nearing completion.

The telescope the second largest in the world, and the largest in the British Empire, exceeded only by one other in the world, that on Mount Wilson, California, is provoking wide spread interest in the astronomical world.

For three years the telescope has been under construction. The administration building, of cut stone, is practically finished. The steel dome, 61 feet in diameter complete to the latest equipment which houses the telescope is finished. The tube itself is installed.

The grinding of the mirror, perhaps one of the longest jobs of all, is well advanced. It has been in progress for many months. The mirror must be correct to the one-millionth of one inch.

The telescope just now has a weird appearance. It might muzzle points to heaven. The tube is 30 feet in length, and nearly seven feet in diameter. It is wide open at the top. At first glimpse it suggests a huge trench mortar, ready for action.

In the bottom of the tube lies the great mirror, face up reflecting a circle of sky. It is about this costly treasure of a mirror that all the delicate machinery and expensive plant of the new observatory, centres.

The mirror is 74 inches in width and nearly a foot in thickness.

The polar axis of the telescope is 22 feet in length and weighs 9 tons. The declination axis moves freely. It is the work-a-day axis of the telescope on which the heavy tube turns.

The tube of the telescope is not altogether unlike a cylinder. The middle section is a steel casting, very massive, supplied on one side with a large boss for attachment to a flange on the end of the declination axis.

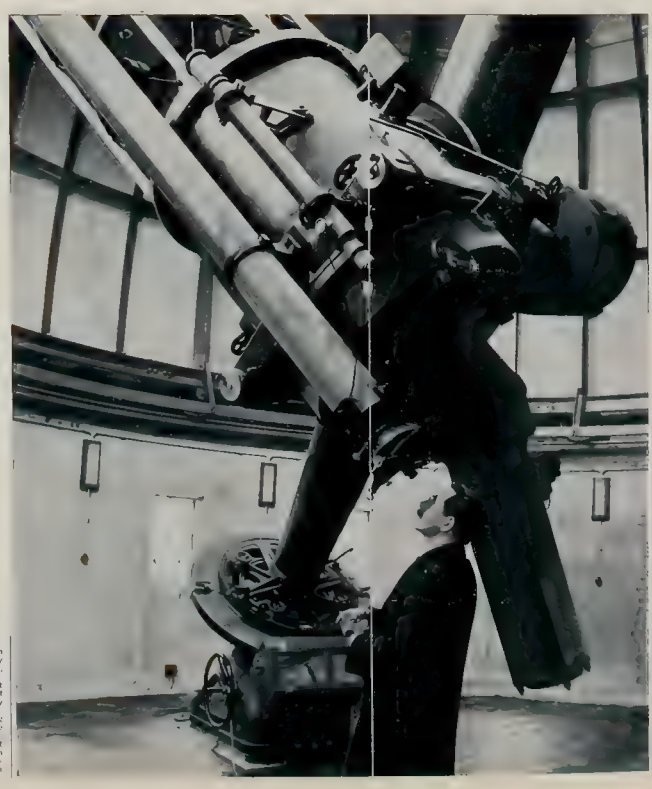
Canada's new telescope will have about 300 times eyepower, and will bring into vision more than 1,000,000,000 stars and thousands of those island universes which are so occupying the attention of the astronomers to-day.

The moon, when it comes up over Richmond Hill next September, will look as though distant only about 50 miles. Mars, the nearest of the planets although about 58,000,000 miles away, will seem much closer. Five years from now it will be about 20,000,000 miles away from us.

The new telescope will penetrate 10 hundred light years into space. How far is that? Light travels 186,000 miles per second. Nobody can comprehend it.

Prof. C. A. Chant is a busy man these days with the new telescope nearing completion.

The "Sphere"
April 21, 1934



A MODERN MECHANICAL MARVEL
Another view of the new Greenwich telescope which has been built by the firm of Sir Howard Grubb, Parsons and Co. of Newcastle-on-Tyne. When "set" the instrument remains pointed at the part of the heavens under observation by electrically controlled clockwork. This keeps the polar axis turning at the rate required to compensate exactly for the earth's rotation. The telescope is designed for use in what is known as Cassegrain form which has many outstanding advantages when used in the analysis of spectra.

Photographs taken May 8, 1934

Another View H.E.P.C. Trench. May 8, 1934

Digging the Trench for the H.E. P.C. Cable. (Looking E.)

Digging Trench for Water Pipes.

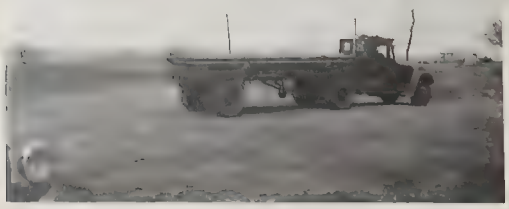
View of Buildings from East.

Dominion Bridge Truck removing planks loaned from Oct. 1933

Repairing the Lane-Looking West.

Dr. J. S. Plaskett, Director, Dominion Astrophysical Observatory Victoria B.C. May 1934

C. A. Chant. Photograph by J.S.P. May 10, 1934



Truck-load of 4-inch Iron Pipe for Water Main. May 10, 1934

Dumping Cinders on the Road. May 15, 1934

Sawing up Rails, Posts, etc. May 15, 1934
Haldane Finney
(Garage behind)

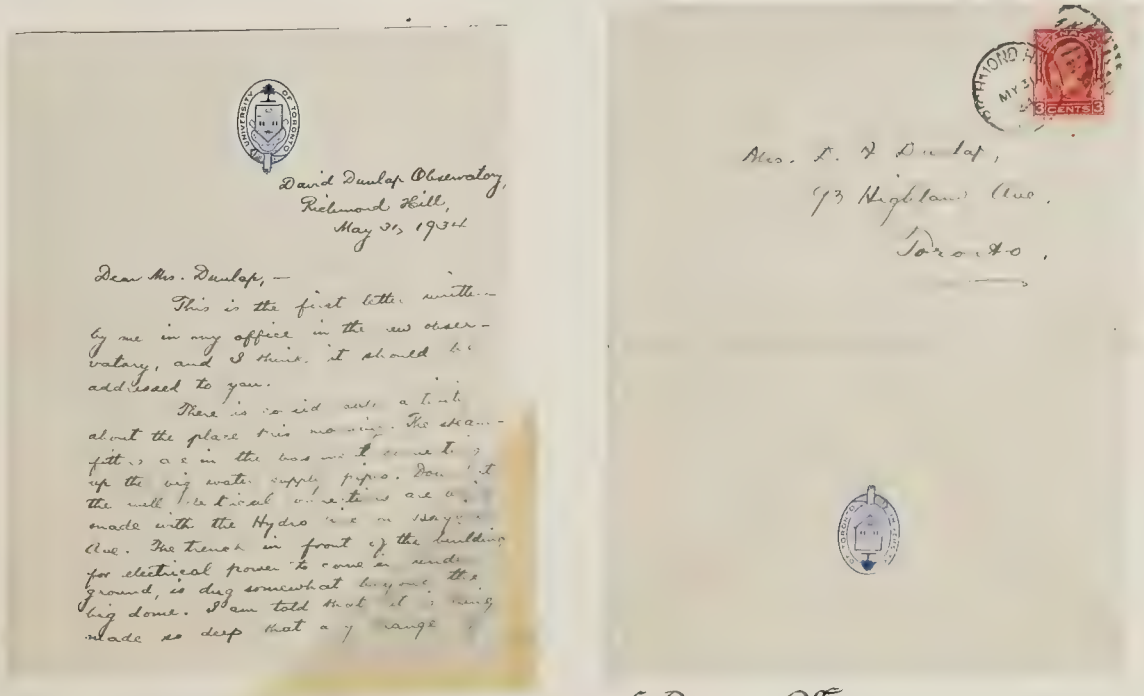
Digging the Trench for the Water-Main. Looking E. near Bayview Ave.
May 15, 1934

Digging Trench for Water Main. Rear of Administration Building - (Looking E.) May 16, 1934

Grading around Administration Building. carrying in Books May 31, 1934

Grading. May 31, 1934 Jordan-Roberts Truck

Another View of the Grading (Looking S.) May 31, 1934



David Dunlap Observatory,
Richmond Hill,
May 31, 1934

Dear Mrs. Dunlap, —

This is the first letter written by me in my office in the new observatory, and I think it should be addressed to you.

There is no sid[e]walk, a foot about the place this morning. The steam-fitters are in the basement putting up the big water supply pipes. Down the mall the electrical conduits are being made with the Hydro [illegible] Ave. The trench in front of the building for electrical power to come in underground, is dug somewhat beyond the big dome. I am told that it is being made so deep that a [illegible]

Mrs. D. A. Dunlap,
93 Highland Ave.
Toronto.

First Letter Written from the Directors Office.

THE GLOBE, TORONTO, SATURDAY, JUNE 2, 1934

THE HOMEMAKER

(Copyright in Canada)

THE HOME FORUM

"Many a night I saw the Pleiads rising through the mellow shade, glitter like a swarm of fireflies tangled in a silver braid."
—Tennyson.

Dear Homemaker: I have enjoyed the recent letters on astronomy, for I, too, am a lover of stars. When a child I read and reread Stories of Starland by Adelaide Proctor, these stories being interspersed with lovely little poems, such as "Wynken, Blinken and Nod," "The Night Has a Thousand Eyes," etc. I have been interested in the subject ever since, and of late have been trying to find a few new constellations each summer when in the North country, where the night has not only a thousand eyes, but it would seem, a billion. I take with me Professor Chant's text-book, "Our Wonderful Universe," which is easy and fascinating reading, and from the Northern Cross, very conspicuous in the Milky Way, I can now find Lyra, Hercules, so like a flower pot; Corona, the little crown; Bootes and then the glorious Arcturus, the brilliant orange star, in the southeast in September.

Did any one listen over the radio last June to the opening of the Chicago Exposition, when the ground, and buildings were flooded with colored lights indescribably beautiful, the power being generated from a beam caught by the great Yerkes Observatory in Wisconsin, from the star Arcturus? It was a wonderfully interesting hour, and I seemed to actually experience a physical shock when the contact took place.

From one corner of the great square, Pegasus hies up in the southern sky. I can now find, too, the Nebula Andromeda, the only one of these great masses of stardust to be seen without the aid of a telescope.

Every one is interested, I am sure, in the great new observatory under construction at Richmond Hill. May I quote a little from an article in the Sphere of April 21 on telescopes in general and this one in particular?

"The seeing part of the human eye is very small. 'How minute are our instruments in comparison with the celestial universe!' once exclaimed El Karakvi an Arabian astronomer, who built a great observatory in Cairo in the twelfth century. He could see about 3,000 stars. Newton's little telescope increased this a hundredfold, making visible about 500,000 stars, thinking of the sky as a whole. Canada's new telescope will have seven hundred times that power, and will bring into vision more than 100,000,000 stars, and inorganic of those little island universes which are so occupying the attention of astronomers today. The moon, when it comes up over Richmond Hill next September, will look as though distant only about fifty miles. . . . Nobody knows what is in store for the great new David Dunlop memorial telescope, except that it will be a marvel."

I apologize for coming again so soon, but I wanted to recommend Professor Chant's interesting and inexpensive book with keys to the summer and autumn stars, to all interested, and may I sign myself as

Arided.

Thank you, Arided, for this fine letter.

Hydro Construction Party. June 12, 1934
During the erection of the Buildings, power was supplied on poles. Then the wires were put underground, and on June 12, the poles were removed.

During construction water had been brought from Richmond Hill.

The last Tank Load of Water, brought from Richmond Hill. June 12, 1934

Pump House in Course of Construction. June 12, 1934

Hydro Construction Party which removed the poles.
June 12, 1934

View obtained from the top of a Hydro Pole, just before the pole was removed. June 12, 1934

University of Toronto
DEPARTMENT OF ASTRONOMY

DAVID DUNLAP OBSERVATORY
RICHMOND HILL P.O., ONT.

July 25, 1934

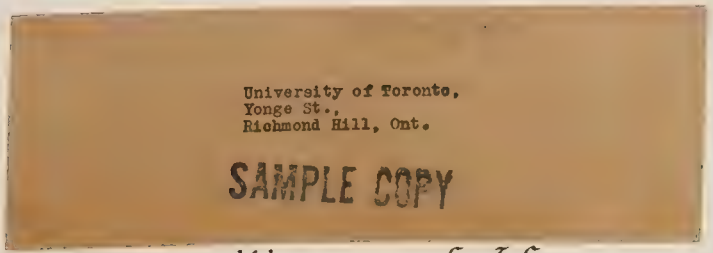
Dear Mrs. Dunlap, —

I came down on Monday, as I proposed, and yesterday called at Rous and Mann's, picked up Mr. Robson (who appears to be their chief authority on art) and we two went over to Highland Ave., to examine Mr. Massey's Book. With it before us we discussed your book for an hour, and in that time made our ideas definite.

Robson has the oak covers and has the style of binding, the hinges and lock, &c., definitely in his mind. He will send me some sketches and I will take them over to you and we can decide on what is best. I will also discuss with you the best method of arrangement, what all to include, and any other details which you may think of.

This afternoon I called at McDonald & Willson's, and they have some fixtures which will probably be suitable for your room and the library. It is astonishing how interested the people are in the Observatory. At McD. & Willson's I met Crane (one of the head men) and Black, and they insist[illegible]

Letter discussing this Album, electric fixtures and other matters.



From a Newspaper Wrapper, received July 25, 1934
(The University moved up Yonge St.!)

July 24, 1934

July 24, 1934

The Summer School in Astronomy visits the Observatory.

The Pump House. Aug. 23, 1934

Evening Standard
LONDON
[illegible] 1934

Empire's Biggest Telescope Weighs 50 Tons

TORONTO, Wednesday.

WHEN the new Dunlap Observatory is opened at Richmond Hill, north of Toronto, shortly, it will contain what is claimed to be the biggest telescope in the British Empire.

The observatory is being given to the University of Toronto by Mrs. D. A. Dunlap as a memorial to her late husband, a Canadian mining man.

The dome and building are practically completed, and part of the telescope is now being put in position. An English telescope firm has had charge of the main reflector, which will soon be installed.

The weight of the telescope and its 74in. reflector is about 50 tons, and the weight of the steel dome about 80 tons.

DOME ON ROLLERS

The dome is carried on 24 canted rollers, of 2ft. diameter, mounted in ball bearings and running on a rail. Sixteen pairs of lateral roller bearings on the inner and outer edge of the rail keep the dome in position.

Two segmental platforms, the lower one at the base of the opening and the upper one at the back, 10ft. higher, are fixed inside the dome.

The centre section of the telescope tube itself is a steel casting seven feet in diameter and weighs 5½ tons.

Just above the lower flange, the casting swells out to 8ft. 7in. to accommodate an iris diaphragm for use in stellar photography.

The shutter of the camera opens to 6ft. 2in., and is operated by a hand wheel.

It is expected to reveal new secrets of the stars.

The Dunlap Observatory is being constructed under the supervision of Professor C. A. Chant, head of the astronomy department of the University of Toronto.—Reuter.

Mr. Cyril Young, Manager of Sir Howard Grubb, Parsons & Co., putting the dark slide into the Newtonian Breechpiece. (See pages 114, 115)

How Many Worlds Can You See?

Science reaches into space to discover new stars whose light started toward us aeons ago

Top left. The Dunlap Observatory, that will house the second largest telescope in the world
Left The great telescope set up in England before shipment to Canada
Right The iris diaphragm.

by Allan Strathglass

ON a clear, dark night, when the rest of the world seems hushed in sleep, how many stars can you see? They seem innumerable, it is true, but actually all that are visible to the unaided eye are some 5,000 or 6,000 and of these not more than 2,500 are visible at any one time. These were all the stars the ancients dreamed of and these are all the savage of today can know, and all that even modern man knew about until the advent of the telescope.

Galileo's crude telescope of the 17th century, enlarged man's vision to add hundreds of thousands of other stars. Since that epochal day, every increase in the power of the telescope has brought out new stars that otherwise would have been invisible. Yet the great galaxy of stars which we are able to view through the ordinary telescope constitute but the nearer fringe of hosts of heavenly bodies so numerous that the mind is staggered by the vastness represented.

At first, in his arrogance or ignorance, man thought of his own planet as the centre of the universe. The world was the most important thing in space and dominated all. The sun, the moon and the stars revolved around the world. Once a day the lordly sun made his trip, in unquestioned obedience to the will of the centre of the universe. From the time man first became cognizant of the apparent motion of the heavenly bodies this idea persisted, persisted right up until a few hundred years ago, when the theory of Copernicus that the earth revolved around the sun was accepted, and the invention of the telescope finally revolutionized the study of astronomy.

Dr. C. A. Chant, Professor of Astro-Physics at the University of Toronto and Director of the David Dunlap Observatory which is to open early next year expressed the idea quite clearly when he stated that in early times "the universe was believed to be but of small extent. The heavens were just overhead and the gods often came down to mingle with mortal man."

"Today" he added, "we know that the sun itself is a star giving out light and heat of itself and the earth is one of a number of much smaller bodies called planets revolving about it. The size of their orbits when expressed in miles seem very large, but when we find out the distances to the millions of other stars which appear as bright dots on the sky we realize that our solar system occupies but a bright pinhead of space, while the rest of the universe is inconceivably remote. The distances from star to star, are not infinite although they are extremely great.

Grinding the edge of the huge reflector lens

"THE nearest star (outside the sun) is the Centaur, which is 270,000 times as far as the distance of the earth from the sun or 25 million million miles. We express this distance in another way. The speed of light is 186,000 miles per second or 11,000,000 miles per minute. While light requires only eight and a third minutes to come from the sun to the earth, it takes over four years to come from Centaur which is therefore four light years away from us."

Four light years away! Can the human traveller comprehend it. The fastest trip ever made around the world by aeroplane aided by every modern means of travel, took some sixty days to accomplish. Yet light travels the same distance seven times over with every tick of the clock. And light travelling four years just manages to make the trip between Centaur and the earth.

If the nearest star is four light years away, how about the others? The distances from the earth of some 2,000 have been measured and they are found to be up to 400 light years away.

Gaze on any one of them. They are quite visible

(Turn to page 40)

HOW MANY WORLDS CAN YOU SEE?

(Continued from page 7)

...as dark night Here is a star that ...nks down on us tonight We see ... brightness But the light we see ... not the light emitted by the star tonight That light which is now ...ible started on its voyage through ...ace when Drake was battling the ...panish Armada

But most stars are even farther ...way Over there is another, the ...ght from which started to earth ...hen Alexander of Macedon was ...eeping because there were no more ...orlds to conquer But Alexander ...died only 2,257 years ago, a comparatively recent date when considering the distances which separate ...rom most of the stars

"We are at majority of stars are immensely farther off than this," ...ccording to Professor Chant and ...ther astronomers The globular ...ar clusters for instance, range all ...the way from 70,000 to 220,000 light ...ears And the nebulae, which are ...o far away that they are hardly to ...be seen with the best of telescopes, ...are much more distant In fact, the ...nearest is 700,000 light years away ...And one recently discovered spiral ...nebula is assigned a light distance ...of 135,000,000 years"

Which means that those stars which are 500 light years away, some 1,870 million million miles, are the nearer stars A billion miles for instance is such a distance as to be almost beyond our mental grasp. But that is only a brief footstep compared with the distance to those stars which science has located a million times as far away again

THE Neanderthal man, believed by science to be the first human type on earth was supplanted by the Cro-Magnon some 30,000 years ago millions of years after the light which is just now visible to us started on its journey to earth The world itself is believed by many scientists to be but a little over 1,500,000 years old yet the light from that newly discovered nebulae mentioned, started on its journey to earth 133,500,000 years before the earth was born

INTERESTING conjecture is possible when considering these great distances It is believed that the stars are moving away or apparently moving away from us at an almost incredible speed So that when one gazes at these distant stars or star clusters through a modern astronomical telescope, he is seeing the star or star cluster, not where it is but where it was anywhere up to 135,000,000 years ago. Millions of years ago that particular star or star cluster may have died out, or some catastrophe may have happened to it and yet it may be millions of years before that could possibly be known to man!

Or put it this way If something happened to Centaur, the nearest star, tonight, say it blew up, that fact would not be known to even the astronomers of the world for four years

Astronomers are probably gazing tonight at some phenomena which passed into history eons before the earth broke away from the sun

GALILEO started all this, with his invention of the telescope And it brought him plenty of trouble because he insisted that the earth went around the sun The Holy Office of The Inquisition denounced Galileo, affirming:

"The proposition that the sun is the centre of the world and immoveable from its place is absurd philosophically, false and formally heretical because it is especially contrary to the Holy Script."

Galileo's telescope consisted of a simple convex lens about two and a quarter inches in diameter At that, it increased the vision of the naked eye to such an extent that it was sufficient to add hundreds of thousands of stars to the two or three thousand previously seen

FROM Galileo's simple arrangement of 300 years ago to the great reflecting telescope of today is a far cry. All telescopes until recent years were modifications of the refracting type as first introduced by Galileo. The modern refracting telescope today is built on the same principle But the reflecting telescopes depend on mirrors for their efficiency The light is collected on a great concave mirror, is in turn reflected to another mirror and the resulting image focussed on an eye piece. The new telescope enlarges our vision, not by a paltry few hundred thousand stars, but by millions. Such a one, adding 1,000,000,000 stars and thousands of island universes to those previously seen, is rapidly nearing completion at Richmond Hill, near Toronto.

This is the David Dunlap Observatory, provided as a memorial to the late David A. Dunlap of Toronto.

This observatory will be the finest of its kind in the British Empire and will house the second largest telescope in the world, second only to the giant telescope on Mount Wilson in California. The observatory and administration buildings are completed, the tube of the telescope is installed and completion only awaits the installation of the great 74-inch reflecting mirror, at present undergoing polishing and silvering in England.

The building is designed to be warm in summer and cold in winter —in fact, the idea is to maintain the same temperature inside as prevails outside

It is about the telescope itself that interest in both the lay and astronomical worlds concentrates. The great tube, thirty-one feet long and seven feet in diameter, is made of steel. With the shutters open and the tube pointed at the sky, it reminds one of a Gargantuan field gun trained on some far-away planet or star. As a matter of fact, to carry the simile to its logical or illogical conclusion — whichever you wish — the range of the telescope is some 135,000,000 light years. In other words, it brings into view heavenly phenomena so remote that it takes 135,000,000 years for the light from them to reach us

WHILE the tube is spectacular in appearance, the main part of the telescope, that upon which rests its successful operation, is the great mirror which is to be fitted into the base All the delicate machinery and expensive plant of the observatory centre about the mirror. This mirror is made of a great circular block of glass, six feet two inches in diameter and a foot thick. When completed it will weigh approximately 5,000 pounds— two tons and a half. In the centre is a circular hole a foot in diameter, and the completed mirror resembles nothing so much as a massive, polished grindstone.

The casting of the three-ton disc of glass for the mirror was a piece of work which offered great technical difficulty In the first place, it had never been done on such a scale before. It could not be done in Canada because no facilities for such work exist The building of a plant capable of doing the work would certainly not justify the expense because the needs of the whole world will hardly permit of more than one or two such plants As mentioned, such a large glass casting had never been made, though larger castings had been made in two parts.

When scientists first attempted the work, they found that the only known available material which satisfied all their requirements was fused quartz glass. But quartz required enormous temperatures for casting. Finally experiments turned on pyrex and it was of this material that the 74-inch disc of the mirror was finally cast

But the casting of the disc — remarkable feat as it was—was just one step in the production of the huge convex mirror for which it was intended It had to be allowed to cool very slowly, else it might check or crack, which would mean that it would be useless. It was six months before the makers ventured to strip away the matrix. When they did so, they were delighted to find that their calculations had proved correct. The great disc was found suitable.

But this was only the start. The disc had to be ground and polished correctly to one-millionth of an inch. And, for that work it was shipped to England, and there, for almost a year, it has been in the process of grinding prior to silvering. If you think this is slow work, please remember that grinding is only permitted for fifteen minutes a day, in case the increased temperature caused by the friction should distort the mirror.

One other feature of the telescope deserves mention. That is the iris diaphragm which is used for protection of the mirror and for the changing of the aperture for the admission of light. This diaphragm is built on the same principle as one in the shutter of the ordinary folding camera, only it is on a comparatively enormous scale, having a maximum opening of six feet two inches.

The Dunlap Observatory telescope is the second largest in the world, being inferior in size and — if one may use the expression—penetrating power, to the Mount Wilson telescope only.

But it is still only a beginning. Already there is talk of a 200-inch reflector. If the 74-inch Toronto reflector can reach out into space for stars 135,000,000 light years away and find them, how many more may we yet see when we have tapped the last resource of human ingenuity.

Canadian Telescope Records First Infra-Red Photographs Of Perseid Meteors at Toronto

Great Dunlap Mirror of 100,000 Eye-Power Searches Secrets of Stratosphere as Told by Annual Wanderers

Special to The Christian Science Monitor

TORONTO—At the Dunlap Observatory of the University of Toronto, Richmond Hill, the recent shower of Perseid meteors was for the first time photographed on infra-red plates.

On each of two nights Dr. P. M. Millman of the Department of Astronomy reported that astronomists counted 500 meteors, although they were disappointed on the third night.

The Perseid meteors, which are seen each year during August, travel at a height of about 70 miles above the earth, at an estimated speed of about 40 miles a second, it was explained. The meteors are usually fragments of some comet broken up by the solar system, travelling in orbits around the sun, and they may be seen when they intersect the path of the earth about the sun.

Pioneer Photographs

A photograph of these meteors in the infra-red has never before been obtained, Dr. Millman pointed out. The interest in them lies in what they may reveal of conditions in the upper stratosphere, 60 miles above the surface of the earth, as well as in the scientific interest with regard to the meteors themselves.

The telescope at the Dunlap Observatory, which has been under construction for the past three years, is the second largest in the world, and the finest in the British Empire. It is second in size only to that on Mount Wilson, California.

It is housed in a steel dome, 61 feet in diameter, completely equipped. At the bottom of a tube, 30 feet in length, and nearly seven feet in diameter, which is wide open at the top, lies the great mirror, 74 inches in width and nearly a foot in thickness. The polar axis of the telescope is 22 feet in length and weighs nine tons. The declination axis moves freely.

With approximately 100,000 eye-power, the new telescope will bring into vision more than 1,000,000,000 astronomical bodies and the moon will look as though it were only 50 miles away. Mars will seem much closer than its 58,000,000 miles from the earth. The new telescope is said to be able to penetrate 140,000,000 light years into space.

Christian Science Monitor (Boston) Aug. 24, 1934

THE TELESCOPE

An Illustrated Magazine of Astronomy

Vol. 1 AUGUST, 1934 No. 5

Canada's Third Large Observatory

The New David Dunlap Observatory of the University of Toronto.

By P. M. Millman
Dept. of Astronomy, University of Toronto

POINCARE remarked that, had man been unable to view the stars, he would still be living in an age of barbarism. Though some may consider this an extreme view, certain it is that man's first conception of natural law and order arose from his observations of the heavenly bodies, and it is equally certain that such observations have played a major part in the guidance of scientific thought from the dawn of history to the present day.

Important as theoretical work is, the greatest need in the development of a science like astronomy is for the accumulation of a vast amount of observational data. During the last twenty-five years the North American continent has easily led the rest of the world in this respect and most of the work has been done at a few great observatories located in the United States. Canada, in the past, has had only two important research observatories, the Dominion Observatory at Ottawa and the Dominion Astrophysical Observatory at Victoria. These are both operated by the Dominion Government. Before the end of 1934, however, regular work will be commenced at Canada's third large observatory, the David Dunlap Observatory, near Toronto.

Toronto has long been an amateur astronomical center, the Toronto Astronomical and Physical Society having been founded in 1890. Later, this developed into the Royal Astronomical Society of Canada which has active centers in all large cities in Canada and members throughout the world. The astronomical department of the University of Toronto came into being about thirty years ago, mainly through the efforts of Professor C. A. Chant, who has been the head of the department since its formation. Toronto had no good observatory, however, and the need for one has been felt for some time. It is through the generosity and farsightedness of Mrs. Jessie D. Dunlap that the new observatory has been made possible. Mrs. Dunlap wished to erect a lasting and fitting memorial to her husband, Mr. David A. Dunlap, who had been a keen amateur astronomer and much interested in the establishment of an observatory in Toronto. Learning from Professor Chant the need for a modern research institution at Toronto, Mrs. Dunlap offered to the University of Toronto, in 1927, the funds for the purchase of land and the erection of an observatory to be known as the David Dunlap Observatory.

In planning a new observatory the site is all-important and tests were made of the atmospheric conditions at various localities near Toronto. The final choice was the

top of a slight rise about fifteen miles directly north of the University. The elevation is 800 feet above sea level, the highest point for some distance, and while the atmosphere is very slightly more transparent further north, the difference is so slight that it is not enough to balance the increased inaccessibility which would result by locating the observatory at a more distant point. The observatory property consists of 170 acres which, at present, is mostly open meadow. An arboretum has been planned by the department of forestry and, when this has been completed, the trees will eliminate, to a large degree, the poor seeing that results from the heat which rises after sunset from ground which has been exposed all day to direct sunlight.

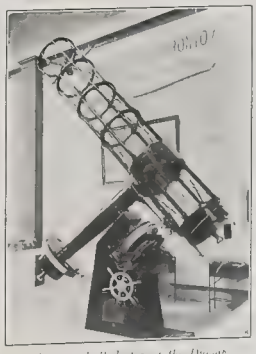
Excavation for the administration building was commenced in 1932 and the corner stone was laid by Mr. D. Moffat Dunlap, son of Mrs. Dunlap, on September 10, 1932. This building is of white stone and is surmounted by three copper covered steel domes, the largest being twenty-five feet in diameter. The entrance hall is lofty and is lined with Italian travertine, the material of which the Colosseum in Rome is constructed. The dedication tablet, in marble, faces the visitor as he enters, and an exceptionally artistic stairway to the second floor winds around three sides of the entrance hall. The administration building contains offices for the staff, a lecture room seating 150 persons, library and stack room, photographic dark room and laboratories, clock room, and a completely equipped machine shop.

A 19-inch reflector is being mounted in the south dome of the administration building. This instrument was constructed in its

The Administration Building of the David Dunlap Observatory

entirety by Professor R. K. Young of the department of astronomy at Toronto. The mirror is of Pyrex and the telescope is driven by the Gerrish electrical drive. No instruments have yet been secured for the remaining two domes of the administration building but it is hoped that a photovisual telescope of about 12-inch aperture will be mounted in the center dome and a battery of fast photographic telescopes in the north dome.

The chief instrument of the observatory is a 74-inch reflector, constructed by Sir Howard Grubb, Parsons and Company of England. This telescope is housed in a 61-foot dome located some fifty yards north of the administration building and it will have, when completed, a light grasping power second only to the 100 inch telescope at Mt. Wilson. The instrument is now mounted and lacks only the optical parts. The main disk is of the special type of Pyrex glass developed for reflecting telescopes by the Corning Glass Works of Corning, N. Y. Its overall diameter is 76 inches, its thickness 12 inches and it weighs in the neighborhood of 5000 lbs. It is now being ground and polished by the Parsons Co. at Newcastle-on-Tyne and will probably be ready for use by the end of 1934 or early in 1935.



The 72-inch Reflector at the Dunlap Observatory

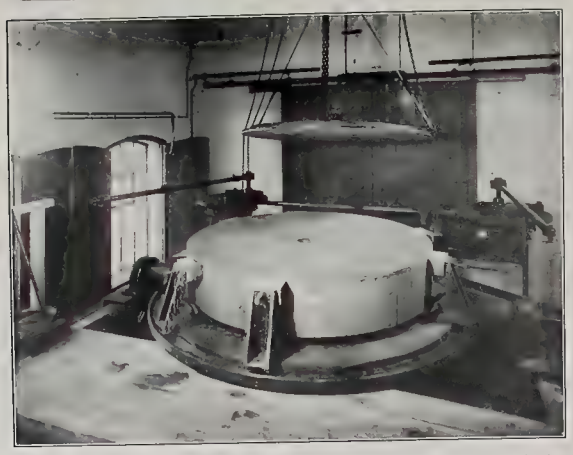
The Entrance Hall of the Administration Building

The 74-inch has an English equatorial mount, very similar to that of the 72-inch at Victoria. The tube of the telescope is of duralumin, which saves considerable weight, and an iris diaphragm is located directly in front of the large mirror, a new departure for reflect

The [illegible] of the David Dunlap Observatory

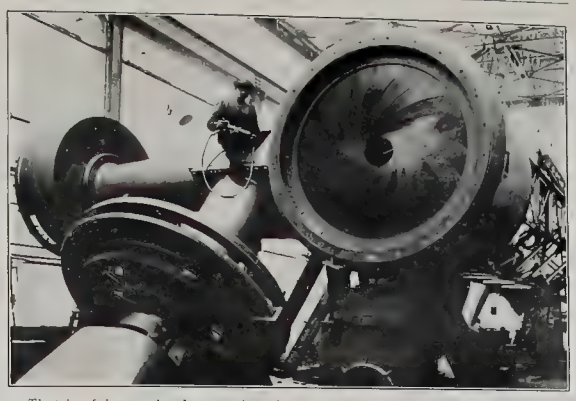
The [illegible] covering the [illegible]

Viewing [illegible] the latter [illegible]



The 74-inch disc on the grinding table The rough grinding of the front surface is completed

The piers of the 74-inch reflector standing before the dome had been erected

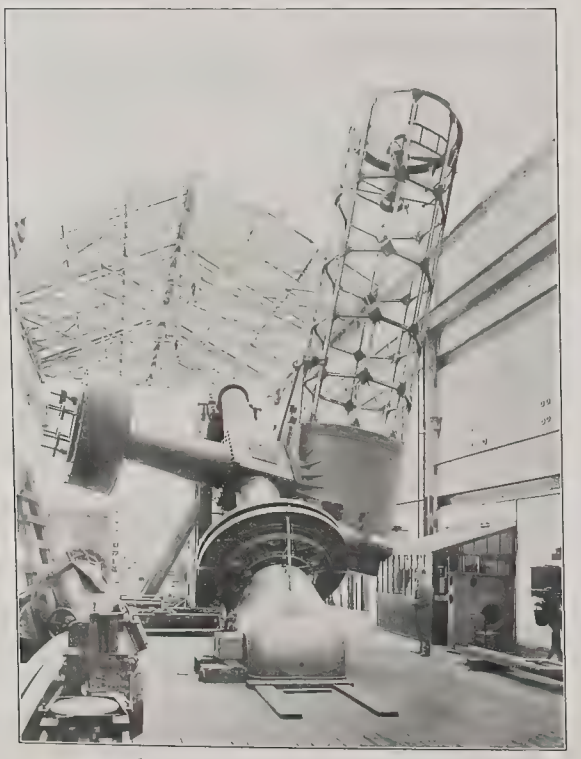


The tube of the 74-inch reflector in place, showing the iris diaphragm at minimum aperture

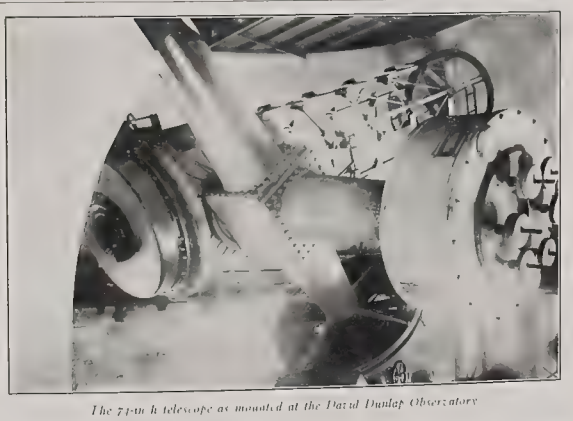
ing telescopes. The instrument is mounted on ball bearings and is supported by two reinforced concrete piers which extend to a depth of 25 feet below the surface of the ground. These are hollow and contain several small rooms which will be excellent for housing seismographs or accurate clocks. A small dark room is located in the upper part of the north pier.

The building housing the large telescope is constructed of metal, the walls being double to permit the constant circulation of air within them. The dome is covered with copper laid over a double layer of heavy agasote, a hard paper product. The observing platform for use at the upper end of the telescope is mounted in a different manner to that employed with any other large telescope. It moves up and down a curved track the whole of which may be moved from one side of the dome to the other which thus facilitates placing the observer in any desired position, no matter how the instrument is placed. This platform is electrically controlled, as is the whole telescope as well as the dome and the shutters. Even the focusing of the cassegrainian mirror is performed by a small electric motor. The makers have spared no pains to make the telescope convenient in operation and efficient in performance.

The telescope is driven to follow the stars by a weight clock so geared that, in effect, the clock is being electrically wound all the time it is running and thus the weight remains in approximately the same position at all times. This



The 74-inch reflector in the shops at Newcastle-on-Tyne



The 74-inch telescope as mounted at the David Dunlap Observatory

clock is synchronized with the sidereal master clock by what is known as the Grubb drive, an electrical synchronization on a somewhat different principle to that of the Gerrish drive.

A special room for resilvering the great mirror is located on the ground floor of the 74-inch dome. The mirror may be lowered into this room from the observing floor by means of a counter-weighted elevator which runs in a shaft extending 25 feet below the ground level. It is hoped eventually to have the surface of the 74 inch mirror aluminum coated, but no equipment for handling a disk of this size has yet been developed. The two secondary mirrors of the large telescope and both mirrors of the 19 inch reflector are now being coated with aluminum through the courtesy of the California Institute of Technology.

The work carried out with the 74-inch telescope will probably be largely spectroscopic, with particular stress laid upon faint objects, where a great field of investigation lies awaiting a telescope of this type. With many new large telescopes either in operation or under construction, the next fifty years should see the solution of a large number of astronomical problems which can only be attacked with great telescopes. Happily the gift of Mrs. Dunlap has made it possible for the University of Toronto to be one of the institutions in the advance guard of our attack on the astronomical problems of the future.

NEW ZEALAND ASTRONOMICAL SOCIETY (INC.)

MONTHLY NOTES.

1934 SEPTEMBER DOMINION OBSERVATORY, WELLINGTON, W.1. No. 93

ANOTHER GREAT TELESCOPE FOR CANADA

The magnificent 72 inch reflector at Victoria, B.C., the second largest in the world and the largest in the British Empire, will soon be eclipsed by one of 74 inches aperture which is being presented to the University of Toronto by the Widow and son of the late Mr. David Dunlap of that City, and in his memory.
It is pleasing to note that such dignified memorials as this, are beginning to take the place more frequently of the ornate and useless structures so often erected in memory of prominent men who have passed away.

It is a source of gratification also to see that the huge instrument is a British production, it having been made at the works of Sir Howard Grubb, Parsons and Coy., Newcastle-upon-Tyne, and the observatory building and dome at Darlington by another English firm. Both were shipped to Canada and are now erected and awaiting the main mirror which is xxxx almost completed. This is also being made by Sir Howard Grubb.

The mounting is of the English or composite type and the weight of the moving parts alone is 35 tons of which the great mirror weighs 2. The driving mechanism is of an improved type that has been fitted to only one other large instrument - the new 36 inch reflector at Greenwich. The difficulties involved in driving such a heavy instrument with the extreme accuracy required for long exposure photography have been aptly summed up in the following interesting manner by Dr.R.K.Young, Pres. of the Royal Astronomical Soc.of Canada.

"A drift of the image of 1/000 of an inch during the course of a photographic exposure would seriously affect the definition of the picture. The engineering difficulties confronting the telescope maker in thus keeping the tube so accurately pointed are about equivalent to keeping a gun trained on a target an inch in diameter at a range of 20 miles while the target is moving at the rate of 5 feet per second." The driving mechanism is electrically wound and it's speed will be automatically controlled every second from one of the observatory clocks.

All the requisite operations of setting, clamping, focussing and slow motions are made electrically under push button control. Some members of this Society doubtless long for the day when push buttons will be standard equipment on home built reflectors. Then it will be as easy to control the movements of a 6 inch telescope as to set, clamp, and drive the 35 tons of a 74 inch.
A feature of the instrument is a large iris diaphragm which is mounted in front of the great mirror and can be opened from a minimum diameter of 12 inches to the full aperture of the telescope. It is claimed xxx that this is the largest iris diaphragm that has ever been made.

The tube, of the usual latticework construction, is fitted with interchangeable Cassegrainian and Newtonian secondary mirrors, each about 20 inches in diameter. The focal length as a Newtonian is 30 feet, and as a Cassegrainian, 111 feet.

The mirror disc is 12 inches thick, of special Pyrex glass having a very tiny coefficient of xp expansion. It was produced at the Corning Glass Works which also cast the disc for the projected 200 inch instrument.

The Observatory itself is a round steel tower 21 feet high surmounted by a dome 61 feet in diameter with 2 parallel shutters opening 15 feet. It is located in a park of 177 acres on Richmond Hill a few miles to the North of Toronto.

The North American Continent will soon have more than half a dozen reflectors of 5 foot aperture or over, but as yet there are none at all comparable with any of these in the Southern Hemisphere where the possibilities of research with such instruments are almost incomparably grander. The Clouds of Magellan alone are worthy of study with the greatest telescopes that man can make.

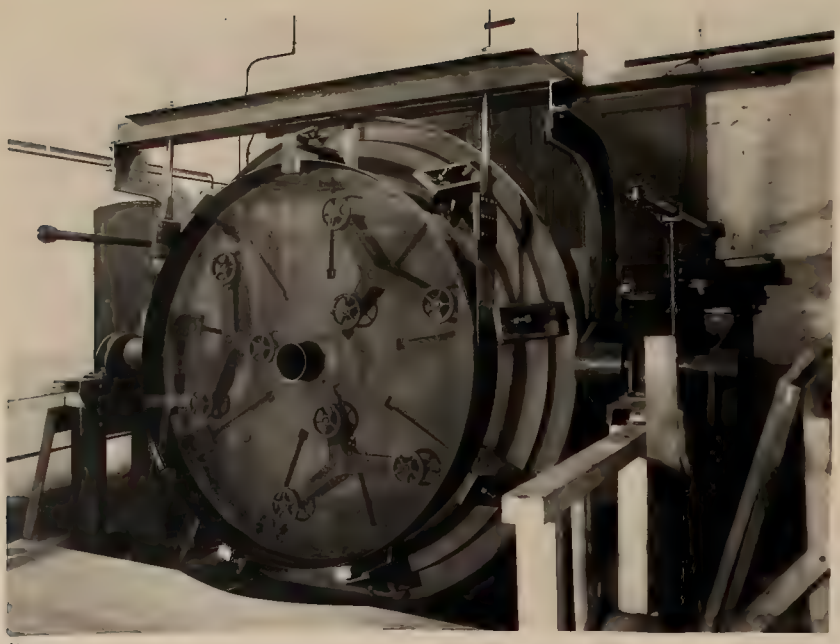
ALLAN BRYCE. Hamilton.

Hamilton, N.Z.

Baling Hay Sept. 19, 1934

Loading Hay Sept, 19, 1934

(Hay crop short in 1934)



No 1061

Main Mirror Tilted up for Testing (Side View Showing belt) September, 1934

No 1062

Main Mirror Tilted up for Testing (Front View) September, 1934

At the Front Door

October 26, 1934

In the
Directors Office

October 22, 1934

In the Entrance Hall.

October 26, 1934

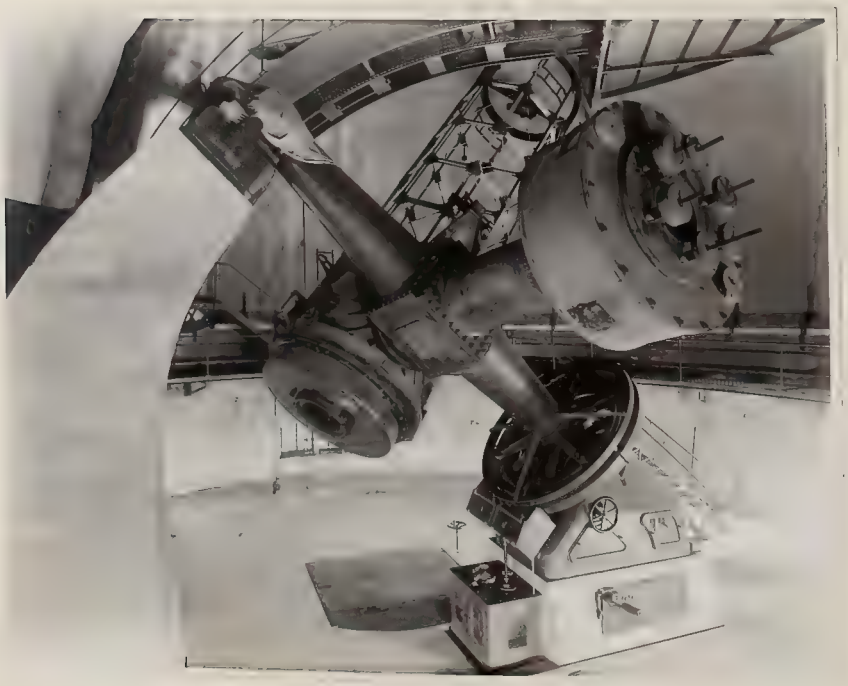
In the Entrance Hall.

At the foot of the Stairs, in the Entrance Hall. October 26, 1934

View of Entrance Hall (Looking West) October 22, 1934

Entrance Hall from Stair Landing (Looking East) October 22, 1934

Mr. Dunlap
Photograph of Oil Painting by Joshua Smith in the Library. Oct. 22, 1934



The Great 74-inch Telescope. Oct. 22, 1934

David Dunlap Observatory

"The Heavens declare the Glory of God"

Christmas Greetings

from

Mrs. David A. Dunlap

Hillside, Rosedale
Toronto

Christmas Card, 1934

54e année. — Tome CV. — N° 25. N° 2732. Samedi 22 Décembre 1934.

LE GÉNIE CIVIL

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SCIENCES

LE NOUVEAU TÉLESCOPE DE 1m 88 DE DIAMÈTRE de l'Université de Toronto (Canada)

Un télescope de grandes dimensions vient d'être mis en service à l'Observatoire David Dunlap, généreusement créé à cet effet par la famille de ce nom, au voisinage de Toronto, à l'altitude de 250 mètres; comme pouvoir lumineux, il se classe immédiatement après le grand télescope du Mont Wilson, aux États-Unis, dont le diamètre d'ouverture est de 2m 50.

L'observatoire qui vient d'être créé est installé dans un parc

Fig. 1. — Le nouveau télescope de l'Université de Toronto. Vue de l'observatoire David Dunlap.

de 70 hectares situé sur une hauteur, à Richmond Hill (fig. 1), à 15 kilomètres au nord de Toronto, dans un site particulièrement propice aux observations. En plus du bâtiment qui contient la coupole du grand télescope visible à gauche de la figure 1, l'observatoire comporte un bâtiment d'administration auquel sont adjointes trois coupoles pour des télescopes beaucoup moins grands que l'appareil principal. Le bâtiment qui abrite ce dernier est de forme cylindrique, de 18m 50 de diamètre. Le plancher d'observation est à 4 mètres environ au-dessus du sol de la construction, des galeries, intérieure et extérieure, ceignent le long de leur périphérie à 7 mètres environ de hauteur.

Le télescope a été construit en Angleterre par MM. Howard Grubb, Parsons et Cie, dont les établissements sont rattachés pour la partie mécanique aux ateliers de construction des turbines Parsons; nous nous proposons d'en décrire les particularités.

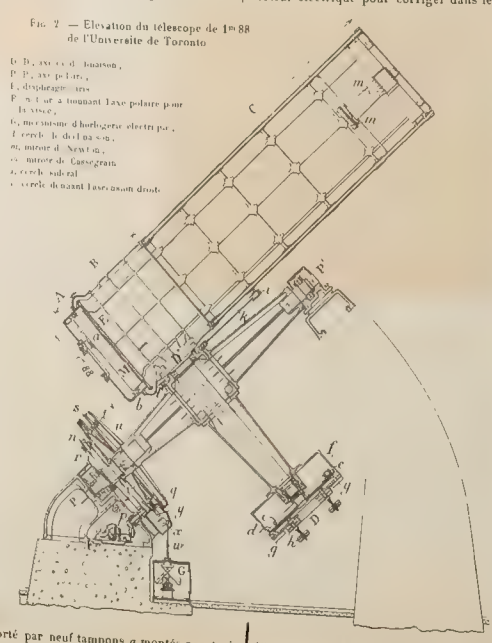
La figure 2 représente en élévation l'ensemble de l'instrument et de sa monture équatoriale; cette monture, ou pied parallactique, est du type anglais, le tube et son contrepoids étant disposés de côté et d'autre de l'axe polaire ou horaire PP'. L'axe polaire est dirigé parallèlement à la ligne des pôles; à cet effet, le palier supérieur est porté par quatre vis et buté dans le sens transversal par quatre autres vis opposées deux par deux, au moyen desquelles on procède au réglage avant de serrer les vis de fixation. Le tube est boulonné à l'extrémité de l'axe de déclinaison DD', perpendiculaire à l'axe horaire; par une rotation convenable du système autour des axes PP', DD', on peut évidemment viser un point quelconque du ciel. Si alors on bloque l'axe de déclinaison par rapport à l'axe polaire, et si tout le système tourne autour de cet axe avec la vitesse angulaire du mouvement diurne, l'image de l'astre visé restera immobile dans le champ de l'instrument.

Le télescope proprement dit peut être agencé, suivant les circonstances, en télescope à vision latérale du type Newton (fig. 3), ou comme télescope à vision directe suivant la disposition inventée en 1672 par Cassegrain (fig. 4). Rappelons que le

B— télescope à vision latérale comporte un miroir plan diagonal m qui, incliné de 45° sur l'axe du télescope et interposé avant la formation de l'image objective A' fournie par le miroir parabolique M, renvoie cette image réelle A_1 qui est observée au moyen de l'oculaire O fixé dans la paroi latérale de la monture, dans le télescope à vision directe, le miroir objectif concave M est associé à un petit miroir convexe hyperbolique m' qui transforme l'image objective A'en

Fig. 2. — Élévation du télescope de 1m 88 de l'Université de Toronto.

D D, axe de déclinaison,
P P, axe polaire,
E, engrenages hélicoïdaux,
F, moteur à tournant l'axe polaire pour la visée,
G, mécanisme d'horlogerie électrique,
I, cercle de déclinaison,
m, miroir de Newton,
m', miroir de Cassegrain,
s, cercle sidéral,
t, cercle donnant l'ascension droite.



une image virtuelle qui est vue par l'oculaire O par une cavité cylindrique, percée au sommet du grand miroir. Le miroir parabolique, en verre pyrex, argenté, a 1m 88 de diamètre net, sa distance focale est de 30 pieds (9m 144), les miroirs véhiculaires sont en crown, celui de Newton a 0m 51, et celui de Cassegrain, 0m 48 de diamètre, ce dernier conférant au système optique une distance focale de 111 pieds 33m 527 (1).

La monture du système optique se compose principalement de la cuvette A (fig. 2), de la virole centrale B avec bossage boulonné sur l'axe de déclinaison, et d'une ossature octogonale C servant à fixer l'un ou l'autre des miroirs véhiculaires, celui de Newton en m, celui de Cassegrain en m'. La cuvette est une pièce nervurée en acier moulé, pesant 950 kg; le grand miroir, qui a environ 300 mm d'épaisseur et pèse près de 2 tonnes, est supporté par neuf tampons a montés par trois sur trois armatures à rotule réglables. Le miroir est centré par de duralumin. Les montures des miroirs véhiculaires s'ajustent dans un cadre en acier, centré par quatre larges rubans d'acier à ressort disposés de champ par rapport aux rayons lumineux. Pour la commodité des observations, quatre positions sur deux diamètres orthogonaux sont prévues pour le miroir de Newton; la monture tubulaire du miroir de Cassegrain contient un petit moteur électrique pour corriger dans le sens axial les déformations d'origine thermique.

Mouvements. — Les télescopes étant destinés aux recherches d'astronomie physique, les mouvements ont pour objet de pointer l'instrument et non de mesurer les positions avec une précision absolue. L'axe de déclinaison DD', de 3m 95 de longueur (fig. 6), pèse 3t 5; il est monté sur roulements à billes à portées sphériques et pourvu d'une butée à double effet à son extrémité inférieure. Sur l'axe est claveté la roue dentée c portant le cercle de déclinaison d de 1m 90 de diamètre, la lecture se faisant par la fenêtre e de la boîte f; deux disques gradués g actionnés par une deuxième roue dentée solidaire de la roue a avec un rapport de multiplication de 1 à 72 permettent de faire les lectures à cinq minutes d'arc près. La boîte f, intentionnellement lourde, et les masses additionnelles h, équilibrent le poids du télescope; à l'intérieur de la boîte est logé un moteur de 0,75 ch qui attaque la roue c par l'intermédiaire d'un

Continued at A.

Continued at C.

A— dix-huit contrepoids b, régulièrement répartis sur la circonférence, montés à l'extrémité de leviers articulés sur la cuvette; le bras court des leviers est en prise avec une patte, rivée sur une ceinture métallique souple qui entoure le miroir sans le serrer. Pour toute position du télescope, autre que la verticale, l'action combinée des contrepoids impartit au miroir une translation qui compense la flexion, due à la gravité.

Sur le bord de la cuvette est fixée la monture d'un diaphragme iris E, à vingt lamelles actionnées par volant à la main, qui permet de faire varier le diamètre d'ouverture entre 0m 30 et 1m 88, ouverture maximum; le diaphragme sert également à protéger le miroir lorsque le télescope n'est pas mis en service.

La virole centrale, également en acier moulé et nervurée, pèse 4t 5; elle est boulonnée à la cuvette. La portée du bossage est plane, mais un bourrelet en saillie sur l'embase de l'axe de déclinaison limite le contact à une ligne circulaire, de manière à limiter les échanges de chaleur pour prévenir dans le télescope, et par répercussion dans le miroir, une dissymétrie thermique, qui se traduirait pour ce dernier par un certain astigmatisme.

L'ossature octogonale, boulonnée à la virole, est en profilés

Continued at B.

(1) Au sujet de la fabrication des différents types de verre pyrex, voir le *Génie Civil* du 28 mars 1931, p. 326.

(2) Nous avons emprunté une partie des renseignements de cet article à une étude de M. Young publiée dans l'*Engineering Journal* (canadien) et à une série de trois articles parus dans l'*Engineering*, auquel nous sommes redevables, notamment, des figures 2 et 7.

C— embrayage électromagnétique, et communique à l'axe de déclinaison un mouvement de rotation d'un tour en huit minutes. L'axe de déclinaison est percé dans toute sa longueur, en vue du passage des conducteurs électriques.

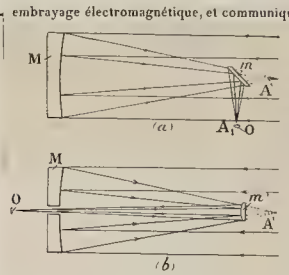


Fig. 3 et 4. — Principes du télescope à vision latérale du type Newton *(a)* et du télescope à vision directe du type Cassegrain *(b)*.

Pour les petits mouvements de rappel relatifs à la déclinaison, la rotation de la lunette est commandée par la vis i tournant dans deux paliers fixés sur deux arêtes voisines de l'ossature octogonale; cette vis tourne dans un écrou, monté à l'extrémité du bras k, naturellement fou par rapport à l'axe de déclinaison, mais qu'une cale, actionnée électriquement au moment précis où le moteur de la boîte est débrayé, bloque sur l'anneau à gorge l solidaire de la monture de l'axe. Un moteur avec démultiplicateur à deux vitesses, fixé sur la virole centrale B, actionne par transmission à la Cardan et renvoi d'angle la vis i, et communique au télescope suivant la combinaison utilisée un mouvement angulaire de 15 minutes d'arc ou de 30 secondes d'arc à la minute.

L'axe polaire (fig. 5), dont la longueur est de 6m 70 et qui pèse 9t 5, est constitué par une boîte cubique, commune avec la monture

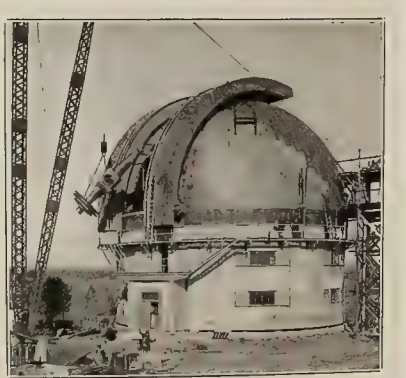


Fig. 5. — Vue prise pendant le montage de l'axe polaire.

de l'axe de déclinaison, par deux trompettes et par deux tourillons; ces pièces, en acier moulé ou forgé, sont montées sur des roulements à billes à portées sphériques, et prennent appui à la base sur une butée. Pour le dégrossissage de la visée, le mouvement de rotation est communiqué à l'axe polaire par la roue dentée n, clavetée sur le tourillon inférieur, en prise avec un pignon actionné à partir du moteur F par l'intermédiaire d'un embrayage électromagnétique; la manœuvre peut également être exécutée en utilisant les volants montés aux deux extrémités de l'arbre p. La visée étant supposée accomplie, il convient, comme il a été dit, d'impartir à l'axe polaire la vitesse angulaire du mouvement diurne; le mouvement de rotation doit être rigoureusement uniforme, ce qui exclut la possibilité d'employer un mécanisme d'horlogerie de construction ordinaire, à mouvement saccadé.

Le mouvement de rotation d'accompagnement est communiqué à l'axe polaire par la roue tangente q, de 2m 438 de diamètre, qui comporte 960 dents taillées dans une jante de bronze rapportée; cette roue, actionnée à partir du mécanisme électrique G, est montée folle sur le tourillon, mais bloquée à la demande au moyen d'un petit moteur électrique monté sur la toile de la roue n ou à la main en utilisant le volant r pour manœuvrer l'embrayage. La roue q est solidaire d'une roue de diamètre un peu plus petit montée au-dessus, laquelle entraîne, par six pignons régulièrement répartis sur la circonférence, le cercle sidéral s, que les volants t permettent de décaler par rapport à la roue q. La jante du cercle sidéral a 75 mm de largeur, elle porte deux graduations; l'échelle inférieure, lue en regard de repères fixés à la garde de la roue q, indique le temps sidéral, et l'échelle supérieure, lue en regard de repères u fixés à l'axe polaire, indique l'ascension droite. Le mécanisme G étant mis en train au crépuscule, le

cercle sidéral est actionné en utilisant l'un des volants t pour régler l'échelle inférieure sur le temps sidéral, après quoi on pointe le télescope avec le moteur F, l'échelle supérieure du cercle sidéral devant alors indiquer l'ascension droite de l'étoile cherchée ; on bloque ensuite la roue q, tout en débrayant le moteur F. Un cercle gradué v solidaire de l'axe polaire permet une lecture grossière de l'ascension droite, en regard d'un repère fixé au socle ; un enclenchement s'oppose à la commande simultanée de l'axe polaire par les deux moteurs à la fois.

Le mécanisme d'horlogerie électrique est représenté en élévation sur la figure 7. Il comprend un moteur de 0,5 ch R, attelé par la roue tangente S et par le couple conique T à l'arbre vertical w qui aboutit au système de commande de l'axe polaire ; sur l'arbre w est claveté un régulateur à bielles croisées, sensiblement isochrone. Les deux parties de l'arbre horizontal reliant la roue tangente au couple conique tournent en sens contraire par l'effet d'un différentiel dynamométrique, équilibré par le contrepoids U suspendu à une chaîne dont l'autre extrémité s'enroule à la périphérie du boîtier V. Les déplacements du contrepoids font varier une résistance, intercalée sur le circuit de champ du

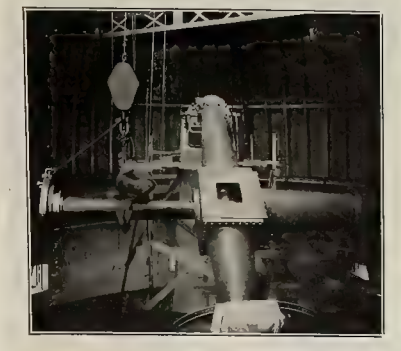


Fig. 6. — Vue prise pendant le montage de l'axe de déclinaison.

moteur ; en outre, le régulateur met en action les frotteurs W en cas de dépassement de la vitesse.

La précision de ce mécanisme n'est pas absolument rigoureuse ; sur la transmission qui relie l'arbre w et la roue q a, par suite, été intercalé un mécanisme correcteur, ou filtre, comportant deux arbres horizontaux x et y. L'arbre x est interrompu par deux systèmes différentiels ; sur la partie médiane est monté avec un certain serrage un disque à encoches, dans lesquelles tombe un

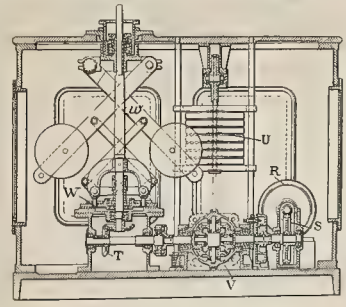


Fig. 7. — Mouvement d'horlogerie électrique communiquant à l'axe polaire la vitesse angulaire du mouvement diurne.

verrou actionné par voie électromagnétique à partir du pendule de l'horloge maîtresse de l'observatoire. Si le synchronisme est en défaut, le disque se trouve decalé dans un sens ou dans l'autre, ce qui a pour effet de faire basculer un interrupteur à mercure à deux départs. Le courant bloque au moyen d'un électro-aimant l'un ou l'autre des deux plateaux portant les satellites du premier système différentiel, ce qui a pour effet d'accélérer ou de ralentir le tronçon d'arbre portant le disque, le deuxième système différentiel est actionné, soit par un petit moteur pour la mise au point de la visée, soit au moyen d'un volant pour corriger les erreurs dues à la réfraction.

Le télescope est équipé de trois chercheurs, de 50, 70 et 115 mm d'ouverture, les deux premiers à l'extrémité de l'ossature octogonale, le troisième près du grand miroir ; pour la vision latérale (miroir de Newton), l'observateur prend place sur la plate-forme d'un chariot électrique, mobile sur une charpente profilée suivant le quart d'une circonférence, roulant à l'intérieur de la coupole sur deux voies semi-circulaires dénivelées de 5 mètres environ. La coupole hémisphérique a 18m 60 de diamètre ; son ouverture, de 4m 55 de largeur, s'étend de la naissance jusqu'à 2m 15 au delà du zénith ; elle pèse 80 tonnes, et

Fig. 8 — Vue du télescope monté dans sa coupole.

repose par 24 galets montés à billes sur le tambour, également métallique, pesant 120 tonnes. La coupole est actionnée par un cabestan électrique.

Le télescope pèse 50 tonnes, dont 35 tonnes pour la partie mobile autour de l'axe polaire ; une fosse equipée d'un monte-charge est prévue pour démonter la cuvette et le grand miroir, notamment en vue de réargenter ce dernier

J. E.

'GUIDING STAR IS A LOT OF HOOEY'

So Declares Dr. C. A. Chant, University Professor

TORONTO, Jan. 1 (CP)— And here's one to ponder in the new year. There is no such thing as a "guiding star" to which you can attribute your share of luck, good or bad, in the past or in the future. The idea that the heavenly bodies guide the destinies of man is just a lot of hooey, a survival of pagan beliefs and superstition, based on the mysterious which gullible individuals are too prone to accept as fact.

We have this opinion from no less authority than Dr. C. A. Chant, professor of astro-physics at the University of Toronto, regarded as one of the world's leaders in this branch of the sciences. The professor, who has devoted most of his life to the study of the mysteries of the universe, has no time for superstition, declaring that luck, chance, fate or whatever you choose to call it is not governed by remote control from the stars, but rather part o human experience, which he said was just as baffling as some of the mysteries which cropped up in the field of astro-physics.

Nelson News, B. C., Jan. 2, 1935
Also in
Charlottetown Guardian, P.E.I., Jan. 16, 1935

CANADA'S MILLION-DOLLAR OBSERVATORY OPENS IN MAY

The new Dunlap observatory, which has been erected at Richmond Hill Ontario, is to be formally opened on May 31, 1935, when many prominent scientists will be present. Among the astronomers who will take part in the opening ceremonies will be Sir Frank Dyson, former Astronomer Royal. Our pictures above show parts of the imposing observatory which will be one of the most modern of its kind in the world. (Insert) Sir Frank Dyson.

Shaunavon Standard, Sask., Feb. 7, 1935
Also in
Kitchener Record, Ont., Dec. 31, 1934
Empress Express, Alta., Feb. 28, 1935

LARGEST TELESCOPE IN BRITISH EMPIRE TO BE IN TORONTO

74-Inch Mirror Now Receiving Finishing Touches in England

DEDICATION IN MAY

Here's one to ponder in the new year. There is no such thing as a "guiding star" to which you can attribute your share of luck, good or bad, in the past or in the future. The idea that the heavenly bodies guide the destinies of man, is just a lot of "hooey," a survival of Pagan beliefs and superstition, based on the mysterious, which gullible individuals are too prone to accept as fact.

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No Time for Superstition.

The professor, who has devoted most of his life to the study of the mysteries of the universe has no time for superstition, declaring that luck, chance, fate, or whatever you choose to call it is not governed by remote control from the stars, but, rather, part of human experience, which, he said was just as baffling as some of the mysteries which cropped up in the field of astro-physics.

Although he had encountered many setbacks in his work, Dr. Chant declared he had never reached the point of utter discouragement or doubted the wisdom of his specialized under' aking.

"I have no hesitation in saying that at least 90 per cent of astronomers have reached the conclusion that the universe is not the result of any blind law, but is regulated by some great intelligence, force or power (call it what you will. There may be some, however, who believe the universe is the result of chance. It all depends on the individual.' Dr. Chant said.

'The planets inhabited? That is a question for the future to determine,' the professor declared. 'There was no reason, however, to believe the earth a tiny speck in the universe, was the only inhabited sphere. But the form of life, if any, on the other planets might be such as to defy the human imagination.

Huge Telescope.

He doubted if the 200-inch telescope mirror recently cast at Corning, N.Y., would supply the solution. This huge "eye," however, will be twice as large as any now in existence, and will enable United States astronomers to probe four times further into the heavens than ever before. It is expected to reveal objects 1,000,000,000 light years distant as they looked many millions of years before even the lowest form of life appeared on earth.

But Dr. Chant is primarily interested in his own minature telescope, which will be officially dedicated on his seventy-fifth birthday, May 31 next. The stand for it has already been installed in the Dunlap Memorial Observatory on the Richmond Hill site, about eighteen miles north of Toronto, and only awaits the 74-inch mirror which was cast by the Corning Glass Works. It is reported that this 74-inch mirror, by experts, is nearly three times as powerful as the 200-inch Mount Palomar Telescope, but it is expected to reach Toronto within the next three months. It will give us the largest telescope in the British Empire, which will enable us to enter the field of astronomical research,' Professor Chant declared.

Also in
Ottawa Citizen, Jan. 2, 1935
St. Thomas Times-Journal, Jan. 5, 1935
Cornwall Standard, Jan. 25, 1935

PROFESSOR NO SUPPORTER OF GUIDING STAR

University of Toronto Professor Declares that Lifetime of Study Has Proved that Fate Is Not Guided by Remote Control from Star

18

To[illegible], Jan. 2—And here's one to ponder in the new year: There is no such thing as a "guiding star" to which you can attribute your share of luck, good or bad, in the past or in the future. The idea that the heavenly bodies guide the destinies of men is just a lot of hooey, a survival of pagan beliefs and superstitions based on the mysterious which gullible individuals are too prone to accept as fact.

We have this opinion from no less authority than Dr. C. A. Chant, professor of astro-physics at the University of Toronto, regarded as one of the world's leaders in this branch of the sciences. The professor, who has devoted most of his life to the study of the mysteries of the universe, has no time for superstition, or anything that luck, chance, fate, or whatever you choose to call it, has to do with control by remote control from the stars, but in their particular existence, which he said was just as baffling as some of the ghosts which are cropped up in the realm of astro-physics.

Although he had encountered many setbacks in his work, Dr. Chant declared he had never reached the point of utter discouragement or doubted the wisdom of his specialized undertaking.

"I would not hesitate in saying, not a few, but 95 per cent. of astronomers have reached the conclusion that the universe is not the result of blind law, but is regulated by some great intelligence, force or power, call it what you will. There may be some, however, who believe the universe is a matter of chance. It all depends on the individual," Dr. Chant said.

Sherbrooke Record, Que., Jan. 2, 1935
Also in
St. John Telegraph-Journal, N.B. Jan. 3, 1935

ASTRONOMICAL SOCIETY

Dr. C. A. Chant, of U. of T., Will Speak at McGill

Dr. C. A. Chant, professor of astronomy in the University of Toronto, will speak on the David Dunlap observatory at tonight's meeting of the Royal Astronomical Society of Canada, Montreal centre, in the Macdonald physics laboratory, McGill University, at 8.30 o'clock. Dr. Chant is director of the observatory which will have the largest telescope in Canada, second only at the present time to the great Mount Wilson telescope.

Montreal Gazette, Jan. 18, 1935

BUILDING OF LARGE OBSERVATORY TOLD

Toronto University to Have Largest Telescope in British Empire

A photographic record of the construction of the David Dunlap Observatory at Toronto, which on completion will house the largest telescope in the British Empire, was shown to members of the Montreal Centre of the Royal Astronomical Society of Canada at a meeting held in the Macdonald Physics Laboratory, McGill University, last evening. Dr. C. A. Chant, professor of astronomy at the University of Toronto and director of the observatory, described the lantern slides which showed in detail the progress of the work which will be brought to culmination in about two months time when everything will be in readiness for the opening of the new observatory.

Prior to Dr. Chant's lecture George R. Lightball was elected unanimously as president of the Montreal Centre of the society for the year 1935. Other officers were also elected by acclamation as follows: Honorary president, Mgr. C. P. Choquette, first vice-president Dr. Julian C. Smith, second vice-president, O. A. Fernier, secretary J. W. Speight, treasurer, Dr. A. Vibert Douglas, Council, Dr. A. S. Eve, Lt.-Col. W. E. Lyman, C. Harper Hall, Dr. L. V. King, E. Russell Patterson, Henry F. Hall, F. De Kinder, and Dr. C. C. Birchard.

The David Dunlap Observatory, an adjunct of the University of Toronto, has been erected with funds provided by Mrs. Dunlap in memory of her husband, who died in 1924, Dr. Chant said. It is situated near Richmond Hill about 18 miles from the Toronto waterfront. The 74-inch mirror which was poured at Corning, New York, is now being finished in England and should be ready for shipment to Canada early in March.

The observatory's administrative building, and the structure which will contain the large telescope, were completed some time ago. The great Mount Wilson telescope in California is the only one greater in diameter than that of the new University of Toronto observatory.

Dr. Chant's lantern slides proved to be a remarkably complete record of the building of the observatory. Every detail of the construction of the building, from the time the foundations were started to the placing of the last bits of stone and steel were shown as well as the pouring of the molten glass for the telescope here at Corning, New York, and the grinding of the mirror in England.

Montreal Gazette, Que., Jan. 19, 1935

SPEED WORK ON GREAT TELESCOPE

Will Have Largest Lens In British Empire

AT RICHMOND HILL, ONT.

Observatory Opening Is Scheduled For May 31

TORONTO, Jan. 22.—(CP) — Since discovery of the telescope little more than three centuries ago, the heavens have slowly yielded some of the profound secrets which through the ages baffled probing astronomers and in this march of investigation Canadian scientists have played an important role.

Among this group is Dr. A. C. Chant, professor of astrophysics at the University of Toronto, who has devoted most of his life to the study of the mysteries of the universe. He declines to discuss himself or his own contributions to science. In his opinion there is a far more absorbing subject — the giant telescope which is being erected under his supervision in the Dunlap Memorial Observatory at Richmond Hill, 15 miles north of Toronto.

The observatory is not only a monument erected through the generosity of Mrs. Jessie D. Dunlap to the memory of her husband, an amateur astronomer, but fulfilment of a cherished dream for Dr. Chant.

It was back in 1907 that he laid the foundation of the present important department of astrophysics at the University and since that day he has looked forward to the time when he would be able to lead his class to wider fields of research with the aid of a powerful telescope. But at the time he thought in terms of a more modest enterprise than the Dunlap 76-inch reflector which will be the largest telescope in the British Empire.

According to tentative plans the observatory will be officially dedicated May 31, Dr. Chant's 70th birthday. Already the huge dome housing the telescope has been erected and the grey sandstone administration building completed. All that is awaited is the all-important mirror, or "eye" of the telescope, now undergoing its final grinding and polishing process at the Parsons Optical Works, Newcastle-on-Tyne, England. This firm is a subsidiary of the Sir Howard Grubb Company which undertook the contract to build the observatory.

Manufacture of the mirror was the greatest accomplishment of the whole undertaking in Dr. Chant's opinion. The experiment in casting the disc has been a long and tedious process and for some time the experts assigned to this technical work were compelled temporarily to acknowledge defeat. The commission was ultimately transferred to a firm in Corning, N. Y., where success attended the pouring of a mammoth 200-inch mirror for a California observatory.

The Dunlap mirror was poured into its mould on June 21, 1927 and on Oct. 1 the same year was declared a complete success. Then it was shipped to England to undergo further technical treatment. Even if the mirror is delivered in Toronto on schedule, nearly two years will have elapsed since work on the telescopic "eyes" was started.

"We shall certainly be happy when the mirror is installed, but we have never been impatient," Dr. Chant said. "I would suggest those afflicted with impatience might try astronomy as a cure." In that field results were far from spontaneous, he said, with a premium rather paid to concentration, determination and patience.

London Free Press, Ont. Jan. 23, 1935
Also in
Leamington Post-News, Jan. 24, 1935
Kirkland Lake, Northern News Jan. 25
North Bay Nugget, Jan. 25
Quebec Chronicle-Telegraph Jan. 25
Niagara Falls Review, Jan. 25
Port Arthur News-Chronicle Jan. 25
Brandon Sun, Jan. 29
Moncton Times, N.B., Jan. 30
Prince Albert Herald, Feb. 1
Truro Victoria-Inverness Bulletin, Feb. 2
Calgary Herald, Feb. 3
Kingston Whig-Standard Feb. 4
The Pas Northern Mail Man. Feb. 8

PLANETARY LIFE MAY BE FOUND BY NEW GLASSES

Astronomer Believes Super-Powered Telescopes Will Reveal Much New Information

Toronto, Jan. 26.—(By Edwin S. Johnson, Canadian Press Staff Writer).—The question of whether the planets are inhabited will ultimately be determined through the advance of astronomy, in the opinion of Dr. A. C. Chant, professor of astrophysics at the university of Toronto.

Research toward that objective has been carried on for many years and now with the advent of super-power telescopes Dr. Chant believes much information hitherto unknown about the nature of the planets and stars will be disclosed to curious mankind. But many years might yet elapse before a definite answer is forthcoming.

With the official dedication of the Dunlap Memorial Observatory at Richmond Hill, on the outskirts of Toronto, Dr. Chant will take his place among the world's leading astronomical research workers. The dedication, set tentatively for next May 31, will bring into operation the largest telescope in the British Empire, a reflector with a 76-inch mirror.

With his staff of expert assistants Dr. Chant plans to devote his first programme of research to spectrum photography of the stars. This, he said, is one of the most fertile fields of study, but the heavens offered such a vast opportunity for research that it would be almost impossible to set a prescribed objective at any time.

Restricted Field

Strange as it might seem, the Dunlap telescope could only function satisfactorily within a restricted field, Dr. Chant said. Its power was such that it must concentrate on the more distant celestial objects. He hesitated to speculate on the possibilities the new telescope opened up. Apart from the spectrum, much remained to be known of the nature of spiral nebulae, radiometry, direct photography of faint celestial bodies and the study of super-novae or 'star suicides." Fifteen of these have been recorded on astronomical photographic plates during the last 50 years. Super-novae are stars which explode into flame 100,000,000 times as bright as the sun.

"No, we will not be out scouting for new stars or planets. That is left for the real watchdogs of the sky, the amateur astronomers," Dr. Chant said. "Of course we may encounter the occasional previously uncharted star, but that will be primarily through accident."

Asked what he thought of the theory recently advanced by a Spanish scientist that the sun was a cold plan et and possibly inhabited, Dr. Chan remarked: "I read about that, bu quickly threw it aside as so much ro Why, do we not get our heat from th sun and is that not proof sufficien that it is not a cold planet? As fo the sun being inhabited, that is an ol theory. Some have advanced the be lief that sun spots are huge crater leading to the heart of the sun wher life might be sustained. We can't deny that possibility, of course, but i there is life there, it is such that i might beggar the imagination."

Brandon Sun, Man., Jan. 36, 1935
Also in
Windsor Border Cities Star, Jan. 26, 1935
Charlottetown Guardian, P.E.I. Jan. 26
Moncton Times, N.B. Jan. 28
North Bay Nugget, Feb. 1

MONTREAL DAILY STAR, SATURDAY, JANUARY 19, 1935

OFFICERS NAMED BY ASTRONOMERS

New Toronto Observatory Described by Toronto Scientist

Members of the Montreal centre of the Royal Astronomical Society last night elected new officers for 1935. George R. Lightball was elected president of the society. Other elections were as follows: Honorary president, Mgr. C. P. Choquette; first vice-president, Dr. Julian C. Smith; second vice-president O. A. Fernier, secretary, J. W. Speight; honorary treasurer, Dr. A. Vibert Douglas, council, Dr. A. S. Eve, Lt.-Co. W. E. Lyman, C. Harper Hall, Dr. L. V. King, E. Russel Patterson, Henry F. Hall, F. De Kinder, Dr. C. C. Birchard.

NEW OBSERVATORY

The meeting of the society was held in the McGill Physics Building. C. Harper Hall opened the proceedings and following the installation of officers handed the chairman-ship over to the new president. The feature of the evening was an address by Dr. C. A. Chant, professor of astronomy at the University of Toronto, who described in detail the construction to date of the David Dunlap Observatory, Toronto, which is now awaiting its "telescopic eye" from England.

The telescope, when completed, will be the second largest in the world. The 76-inch eyepiece is of the reflecting, or mirror type. Dr. Chant explaining that the mechanical difficulties made it impossible to construct a refracting type telescope of this size. The glass in the telescope, poured in the United States, is 76 inches in diameter and almost a foot thick. It is being ground down and polished in England.

The speaker was thanked by Dean A. S. Eve, director of the McGill Physics Building and member of the society, who paid glowing tribute to the fine workmanship which made such a telescope possible as well as to the vision and perseverance of Dr. Chant.

Pictures of Observatory Are Shown to Society

Toronto's new observatory to hold the largest telescope in the British Empire, will be ready within two months, Dr. C. A. Chant, professor of astronomy at the University of Toronto, told the members of the Royal Astronomical Society of Canada, Montreal centre, at a meeting held in the Macdonald Physics Laboratory, McGill University, last night.

Pictures of the progress of the David Dunlop Observatory were shown. Prior to the lecture George R. Lightball was elected president of the center for 1935. Mgr. C. Choquette was named honorary president. Others elected: First vice-president, Dr. Julian C. Smith; second vice-president O. A. Fernier, secretary J. W. Speight, treasurer, Dr. A. Vibert Douglas. Council: Dr. A. S. Eve, Lt.-Co., W. E. Lyman, C. Harper Hall, Dr. L. V. King, E. Russell Paterson, Henry F. Hall, F. De Kinder, and Dr. C. C. Birchard.

Montreal Herald, Que. Jan. 19, 1935

A Monocle 2½ Tons

The huge telescope of the D. A. Dunlap memorial observatory at Richmond Hill, Ont., which, when completed this spring, will be the largest telescope in the British Empire. This photograph was taken in the observatory. RIGHT, part of the canal system of Mars as seen through the helping eye of a powerful telescope.

SOME night this spring a group of astronomers of the University of Toronto, excited as schoolboys with a long-desired toy, will begin a study of the stars through the biggest telescope in the British Empire.

With a mirror of 74 inches, it will outnose the telescope of the observatory at Victoria, B.C., by a scant two inches from its present premier position as the empire's greatest.

Not that Toronto astronomers, their thoughts on the heavens, are boasting about any such mundane victory as crowding out Victoria's star gazers. Indeed, Prof. C. A. Chant, head of the department of astronomy at Toronto, implied that the local telescope and that at Victoria would be virtually twins.

What are two inches anyway when it's a question of peering through millions of miles of space and recording the vagaries of suns hundreds of light-years distant?

The new telescope will be at Richmond Hill, 800 feet above sea level and 10 miles north of the Toronto city limits, where the D. A. Dunlap memorial observatory is being completed to house this great piece of heaven-measuring apparatus which is to be the second largest in the world, second only to the famous one with the 100-inch mirror at Mount Wilson observatory, California.

In fact, the new observatory with its involved mechanisms now merely awaits arrival of the 74-inch mirror which will be its crowning core and glory. This mirror, nearly 2½ tons in weight, has been undergoing more than a year's grinding and polishing at Newcastle-on-Tyne, North England. Some of these days it will be ready for shipment—and it will be shipped more carefully than a hive auk's fresh egg.

By that time, 74 inches in diameter, 12 inches thick at the edge and 11 inches in the middle—concave and spherical, though not a perfect sphere, according to Prof. Chant—it will have been ground and polished to within one-half millionth of an inch of the specifications prepared by himself, Prof. R. K. Young and other colleagues.

"That," said Prof. Chant, with pride, "will be all the difference that will exist between the finished shape and the computed shape. Oh yes, it has been cast and ground according to our computations. It will be tested to this extreme accuracy before being sent to us."

Why, one asked, had Toronto planned for a 74-inch mirror? Why not an 80 or 90 inch one?

As a matter of fact, Prof. Chant admitted, prices had been asked on mirrors from 60 inches up to 76. It had been decided to order one of 74-inch diameter. Indeed yes, he went on, the addition of two inches made a very big difference in the cost of the giant casting of so much pyrex glass and its subsequent grinding and polishing.

Two Years in the Making

NO matter how you regard it, that mirror will be some moncle with which he and others will view the stars. It will have been nearly two years in the making and will have made two transatlantic voyages before it is installed in the great Richmond Hill telescope Actually, in its crude state, it has already been in Montreal. Here's how:

It was cast at Corning, N.Y., on June 21, 1933, was shipped to Montreal, arrived there October 5, left on the 15th for England where it has been ever since, being ground and polished. Now, some of these weeks, it will be back in Montreal but a very different mirror from the rough chunk it was before.

It will be powerful enough to reflect the presence of stars, invisible to the naked eye, whose light has been thousands of years reaching the earth; catch gossamer wisps of nebulae floating as ghosts about the odd corners of heaven and magnify them into shrouds and sheets of dancing draperies; and show up all the craters, earbuncles and wrinkles on the face of that ol' man moon so that he appears rough as a wart-hog—though seen from the garden, his cheeks look smooth as if he had been listening in on radio broadcasts and using some highly advertised complexion cream.

Some moncle! It was cast, according to Prof. Chant, at a temperature of 1,500 degrees centigrade which is 2,700 degrees Fahrenheit, the scale whereby we measure our daily weather. That was hot, as hot, in fact, as some of the cooler stars.

At that temperature the mirror was simply a glowing unapproachable mass of viscid terror.

This temperature was allowed to drop to 500 degrees C. or 900 degrees F., which is considerably above the boiling point of an egg. Then the mirror was placed in an annealing oven and left there for three months, while the temperature, by most minute regulation, was gradually lowered to normal.

Why was it necessary to take more than three months to cool this mirror down through 800 odd degrees to an ordinary earth temperature?

"So that it might be perfectly uniform," said Prof. Chant. "To prevent flaws. You see one end will be cooled, I suppose, more than the middle. Even a fraction of a degree in it. It was perfect."

Such is the mirror which will have a magnification over the human eye of some 10,000 times. That is according to Prof. S. H. Hogg, young scientist who has served as attendant astronomer at the Dominion astrophysical observatory at Victoria and has come to Toronto to help handle this mighty mirror of Richmond Hill and make it deliver the heavenly goods.

That seems a lot of magnification. A mouse magnified 10,000 times would almost be as big as an elephant. It would almost make the gaping woman peer that he might with the aid of binoculars, cull specimens of Mars browning and Venus powdering her nose. But that is too much to expect, as will presently appear.

For one thing, astronomical distance are too great. Consider the moon which Kate Smith has made to seem so intimate. It is not much of a moon, all things considered. Its diameter is only 2,160 miles or about the distance between Toronto and the Prince of Wales' ranch at Hay River, Lower Canada, which is a small diameter indeed—viewed at a distance of 2,000,000 miles, which is the moon's distance from the earth.

Still the great telescope will make it possible to see the moon with considerable close-up satisfaction.

On Old Man Moon

IF you were on the moon, had a telescope like the Richmond Hill giant and were at Canada and focussed on the aforesaid strip, you would be able to call out Toronto, Winnipeg, Regina and Calgary and if you were further west, the Rockies would stand out like sugar-coated plasticine models.

As for the Great Lakes, they would be plain as plain, but you could not pick out the biggest freighter on the lakes, a train puffing through the mountains or Mayor James Simpson walking down Bay St.

Prof. Hogg did with some diffidence admit that if there were an institution as big as the University of Toronto or the Canadian National Exhibition buildings on the moon, you might be able to pick out the outlines with the aid of the new telescope, but that is as far as he would go. He made it pretty plain that there were no mayors or men in the moon, no cities, no institutions as big as the U. of T. or the C.N.E.

As for water or snow, there is none on the moon. If there were, it would glint, but there is no glint from its dead volcanic surface. But it has great craters, which will be clearly visible, and mountains which cast shadows when may be seen and measured. The astronomers—thanks to such great telescopes as the one which Toronto will shortly have—even have names for them. The highest peak of the Apennines range up there on the man moon is Mount Huyghens, 19,000 feet; and there are Mount Bradley and Mount Hadley, each over 15,000 feet. Even the latter are at least 2,000 feet higher than the highest peak of the Canadian Rockies.

The moon, however, is a nearby neighbor compared to the planets. As for the star well, there's distance!

When the planets are nearest to the earth, Venus is said 26,000,000 miles away, Mars 35,000,000 miles and Mercury 57,000,000 miles. The sun is about 93,000,000. The other planets are increasingly distant. Pluto, the outermost discovered planet, is forty times as far away from the sun as we are.

And the stars! The star nearest to the earth, Proxima Centauri, a faint lad down in the southern hemisphere and not visible in these parts at all, is some 25,0 0,000,000,0 0 miles away. How do I know? Ask Jeans and the rest of them. That's what they say.

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This immense glass disc, above weighing nearly 2½ tons, is shown during the grinding and polishing process at Newcastle-on-Tyne, Eng. When finished, it will become the 74-inch mirror which will be the core of the new telescope at the Dunlap observatory. LEFT, Prof. C. A. Chant, head of the department of astronomy, University of Toronto, who will be in charge of the observatory. He will be assisted by Prof. S. H. Hogg, ABOVE, LEFT, who has recently come to Toronto from the Dominion astrophysical observatory at Victoria, B.C.

Some, brightest object in the whole sky, is 51,000,000,000,000 miles away, twice as far as Proxima Centauri, but it gives, they say, 20,000 times as much light as Pat, and that's some light to come so far.

I could go on bringing you stars like that over increasing distances (taking the astronomers' word for it—until your head aches.

There are stars, clusters, galaxies, nebulae. In the milky way and in backwaters of the skies of which you are not even aware with the naked eye, but which the telescope will catch in ghostly flakes, are evidences of a stellar population so distant as to make your brain reel trying to grasp their meaning.

It takes the light from certain clusters 185,000 years to reach the earth. Dinosaurs were lumbering across the face of the earth and pterodactyls swooping down to peck at mammoths for lunch when that light started on its travels.

But that's nothing. The nearest nebula is 850,000 light years away from the earth. Which is a mere bagatelle compared to the most distant nebulae revealed by such telescopes. Their light takes 100,000,000 millions of years to reach us. It has been a long time reaching. When that light, which one of these days the Richmond Hill mirror will detect, started, there was got much of an earth.

At least, it was a pretty hot pot.

The Mount Wilson observatory with its 100-inch telescope has actually photographed the farthest known depth of space to hold a cluster of nebulae which are alleged to be 300,000,000 light years away.

That gives an idea of the power which will be resident in the new telescope. But those people who expect to be able to peer at Mars or Venus as they look across the street at the houses opposite are going to be disappointed.

Prof. Hogg explained that. "The pupil of the eye," he said, "is perhaps one-third of an inch. The amount of light it receives from a star is a mere pencil, like a ray such a you may have seen coming through a crack into a shaded room. When you use a telescope with a mirror 74 inches in diameter you are increasing the reception by over 200 and are receiving a beam instead of a ray, with an area possibly as big as these two tables put together.

"Yes, of course, the bigger the mirror, the bigger the beam you get, being the more you see."

Empire's Greatest

"DOES the two-inch increase in diameter over the Victoria mirror give an appreciable increase in results?"

"No, not to the unaided eye. You could scarcely measure the difference, but it would give approximately 6 per cent. more light."

"Does the location, Toronto or Victoria, 1,000 miles apart, make any difference?"

"No, the only difference for ordinary stellar work would be due to the difference, if any, between each local atmosphere. Otherwise, results would be substantially the same. The time of 'night' arrival would be three hour different, so that, for rapidly changing phenomena, there would be a difference in observation.

"For a new star like Nova Hercules, which sets shortly after sunset, the two observatories so far apart would have great value in making it possible to double, one might say, the time possible for observation, for after Toronto was through with Nova Hercules it would come with a view of Victoria."

Toronto he admitted, had this advantage over Victoria—while both could see all the stars of the

Continued on next page

This remarkable picture, based on actual astronomical photographs, indicates that the lunar poles, like those of the earth, are covered with snow. The picture shows the moon's south pole.

northern hemisphere, Toronto, being south of Victoria, could see about 5 per cent. more of the southern stars than the Pacific city. That, at least, is something to brag about.

All, but on the other hand, Victoria being farther north, has a better winter's air and therefore longer time for observing the stars. But Victoria has Toronto outdone there, which makes us even about even, too.

In fact, one of Prof. Hogg's photographs of the moon, now made by the 74-inch mirror would be on a slightly larger scale than Victoria's, but only slightly, according to Prof. Hogg, as to be almost imperceptible. There was this advantage, or what it was worth. If the seeing were limited, since the Toronto telescope admitted 6 per cent. more light, it would be possible to make a record of this or that 6 per cent less time.

Talk turned to what one might see on the moon, but Prof. Hogg was cagey and would not commit himself. The moon's appearance was, it appeared, an old story. He admitted, however, that one might see the polar snow caps of Mars; at least, it is possible to record them in photos.

But Mars, seen through the telescope or photographed, will show little detail. At the best, it will look little better than those photos of eclipses in which the medium makes, all-in-all, that they are your great-grandfather or the spirit of you dear dead Dido.

Venus, being covered with an atmosphere of thick cloud density, will simply look like a small blob of London fog. That would rather seem to dispose of the telescope as a kind of stellar field glass, making it possible to see the distant stars as closely as we watch racehorses down the back stretch from the grandstand.

What good, then, is this big, expensive mechanism which is hailed as the empire's greatest telescope, second greatest in the world, if you and I can't look right through and see if Mars is populated or what's afoot on Venus?

Prof. Hogg made that clear. Its chief purpose, as has been the chief purpose of Victoria, will be photographic.

It would appear that at Victoria he very rarely looked at the heavens through the great telescope there. The latter was too busy every available hour of the night making photographic records on a scientific basis to leave much opportunity for human peeking.

"Astronomers," said Prof. Hogg, "don't really see much through their telescopes."

Such telescopes act mechanically, it would appear, to record the might, majesty, mystery and movement of the heavenly bodies. Actually, one get the impression of them as radio receiving sets tuned in on the heavens to record, not by sound, but by light through photographs. Probably 95 per cent. of their effort, according to Prof. Hogg, is taken up with spectroscope work, that is gathering in as much stellar light as possible and feeding it into the recording mechanism.

A spectrum, as you know, is the rainbow result obtained when light is broken up. Thus spectroscopically, the telescope records the physical properties of the stars.

As your radio receiving set tunes in on stations of different wave lengths, so will this telescope, as I understand it, tune in on stars of different wave lengths of light. Light and radio are, after all, the same idea. This element or that, broadcast as light energy by this star or that, will reveal itself whether it is, for example, iron, hydrogen or calcium. Each will come in as a band of definite, limited color.

From such records the astronomer can tell not merely the composition, but the speed, temperature, candle-power, pressure of the star, in fact its character, behavior and antecedents.

The least little displacement of pitch or shift, the slightest vagary in its corner of the sky, over a series of records, will tell all sorts of things which may be measured, to the photo-opher.

It's not unlike the radio, you see. If you have been getting a certain station satisfactorily for weeks at exactly 690 and suddenly discover that it is coming in on 691, then, if your radio is right, you'll know that something has changed in connection with the station.

On the other hand, if after weeks of clear reception of such a station, you begin to discover interference, hints of other sound creeping in, you'll naturally conclude that another station has sprung up. That, very roughly, is how new stars are discovered.

You may imagine the work along these lines which will be done at Richmond Hill when Prof Hogg and that in 15 years Victoria had built up a file of 23 000 spectroscopic photographs.

On clear nights, from sunset to dawn, astronomers at Richmond Hill will not be idly peering at the stars, exclaiming, "Boy, there's a bright one!" but will be working like studio photographers during a Christmas rush taking their spectroscope pictures by a most involved mechanical and mathematical process.

In fact, the probability is that the only time they will take leisure actually to look at the stars will be on Saturday nights, when it is more than possible the telescope will be given a popular night off so that visitors may come to the observatory and see what the heavens look like when they are 40,000 times magnified.

That will be well worth seeing, even if the detail may, from what I have written, sound disappointing. The vision will not be disappointing. Nebulae which the naked eye can scarcely see will show up as irregular gonfalons of superb mystery. Some stars, single sparkling jets to the naked eye, will show double.

In an eclipse of the sun such a telescope will be very valuable to record photographically the leaping, heaving prominences of the sun. Similar mirrors have made it possible to show such prominences leaping as high as 367,000 miles above the sun's surface. That's twice as high as the distance between the earth and the moon. Fortunately for us, though, the sun is nearly 93,000,000 miles away, else when it started throwing up these fountains of flame it would be just too bad for us humans.

Deep-Well Water Supply for David Dunlap Observatory

Supply with Capacity of 100 g.p.m. Located by Third Test-Hole—Automatically Operated Pump in 12-In. Casing Delivers 50 g.p.m. Through 2,500 Ft. of 4-In. Pipe

By J. SHORTREED
Assistant, Superintendent's Office, University of Toronto

THE David Dunlap Observatory is situated between Yonge St. and Bayview Ave., about one mile south of Richmond Hill Village, Ont., and about nine miles north of Toronto. Here is housed the largest telescope in the Dominion. The 74-in. reflector is in one large dome, and space for three smaller telescopes is provided on the roof of the adjacent Administration Building.

The observatory was a gift to the University of Toronto from Mrs. Dunlap, in memory of her husband, the late David A. Dunlap, and was constructed during 1933 under the direction of the superintendent of the university. The Administration Building and the foundations for the great telescope were designed by Mathers & Haldenby.

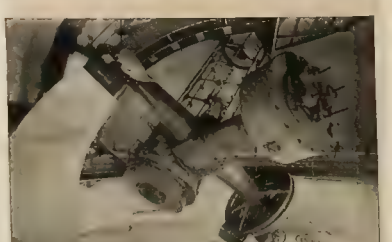
THE DAVID DUNLAP OBSERVATORY, NEAR RICHMOND HILL, ONT.

The water supply for domestic use was a separate problem. It was at one time hoped that surface wells on the property, which covers 187 acres, would supply the necessary water for the buildings and for the residence of the director, Dr. C. A. Chant, but, after the history of wells in the neighborhood was ascertained, this prospect was soon abandoned.

The next step was an estimate of the cost of a pipe line, booster pump, and the purchase of water from the village of Richmond Hill. Consideration of this estimate warranted expenditures to discover the possibilities of water from a deep-well supply on the premises, and arrangements were made with the Jordan-Roberts Sales Ltd., Brantford, Ont., for a survey and a series of drilled test-holes. There were a couple of old flowing wells to the northwest of the property, and a recently drilled deep-well on the Jail Farm about one mile due south. The Department of Geology at the university stated that, in

A—drove a 6-in. reinforced screen 10 ft. long, replacing about 2 yd. of sand, immediately surrounding the screen, with pea gravel. The well at this stage was bailed for approximately one hour at a rate of 120 g.p.m., with a drawdown of 16 ft., the static level being approximately 3 ft. above ground-level.

The pump used was a "Peerless" deep-well pump, driven by a Robbins & Myers 7½-h.p. three-phase motor through a V-belt drive. Due to the distance from the observatory buildings, it was most economical to bring a separate Hydro service from Bayview Ave. Control for the pump had, therefore, to be located in the pump house, and a simple pressure-contact instrument was used, with a small pressure surge-tank in the control circuit.



TELESCOPE AT DUNLAP OBSERVATORY, DURING ERECTION

The water is pumped through 2,500 ft. of 4-in. cast-iron main to the building, in which is located the 600-gal. storage tank and a 42-in. diameter zeolite softener supplied by the Permutit Co. Provision is made that the supply for the sill cocks and watering hydrants does not go through the softener.

Samples of raw water from the well, tested by the Department of Health of the province of Ontario, gave a bacteriological rating of "A" and the following analysis:

Alkalinity	250.0	parts per million
Soap-consuming power	350.0	" " "
Iron, in unfiltered sample	2.0	" " "
Iron, in filtered sample	0.2	" " "
Chlorides	3.0	" " "

The alkalinity and the soap-consuming power are in terms of carbonate of lime.

The pump-house is a small brick structure, just large enough to house the pump and the control apparatus. It is lined with insulating material, and kept at a temperature not lower than 40 deg. F., by automatically-controlled electric heaters.

Since the installation was completed, the system has functioned perfectly, with a minimum of attention.

The first test-hole was therefore located conveniently to the buildings, 200 ft. to the east. This test showed boulder clay mixed with small quantities of sand and gravel, non-water-bearing, for a depth of 242 ft., where shale was encountered and the test discontinued.

The second test-hole was sunk as far west toward the flowing wells as it was possible to go and remain on the property. This showed the same formation, and shale was reached at 200 ft.

The third, and successful, test-hole was 2,500 ft. due east from the building, being 125 ft. from Bayview Ave. This hole showed boulder clay, sand and gravel to a depth of 90 ft., and from 90 to 98 ft. was in a water-bearing strata varying from a very fine gravel to quicksand.

An attempt was made with a fourth test-hole to pick up the strata 800 ft. nearer the building, which would have saved considerable on the pipe line, but the drill was driven to 165 ft. without success.

The first test-hole was started August 10, 1933, and the fourth completed November 22, 1933.

Assurance was given by the drilling contractor that he could develop a well with a capacity up to 100 Imp. g.p.m., but it was decided that 50 g.p.m. would be sufficient capacity for any future development and also give good pressure for watering the lawns, so the contractor was instructed to develop the well to 50 g.p.m. and install pump, softener and distribution system in proportion. To this end, he drilled for, and placed, a 12-in. outer casing, and

Continued at A.

Montreal Star, March 2, 1935

Mrs. Dunlap Gives Toronto Empire's Largest Telescope

TORONTO [illegible] the near future Canada will have the largest telescope in the British Empire, and one of the most modern observatories in the world. The observatory proper will be located at Richmond Hill, north of Toronto, in a 177-acre park.

This plant with its up-to-date machinery and giant telescope is expected to reveal to Canadian astronomers many new secrets of the stars. Constructed and equipped under the supervision of Prof. C. A. Chant, head of the astronomy department of the University of Toronto, the observatory will shortly be ready for use. It will then be turned over to the university by Mrs. D. A. Dunlap, the donor, as a memorial to her late husband, a prominent mining man.

The dome and building are now practically completed and part of the telescope is being set in position. A large English telescope works has been finishing the main reflecting for some months. This too will be in place shortly.

In the huge steel dome will be located the telescope with a 74-inch reflector, the entire assembly weighing around 50 tons. The steel dome is 81 feet in diameter with a parallel opening 15 feet wide. Two moving shutters running on rails at top and bottom of the dome close the opening and are operated simultaneously by means of wire ropes connected to a motor gear. An emergency hand gear is also provided. Two motor-operated wind screens of sail cloth are mounted in the opening one rising from the bottom, the other descending from the top.

The dome, which weighs about 50 tons, is carried on 24 canted rollers of 25-inch diameter, mounted in ball bearings and running on a rail. Sixteen pairs of lateral roller bearings on the inner and outer edge of the rail keep the dome in position. Two segmental platforms, the lower one at the base of the opening and the upper one at the back 15 feet higher, are fixed inside the dome. Rails are mounted on the parallel straight edges on which runs a bridge five feet six inches wide and divided into two portions, the right hand side forming a stairway, the left being a track on which a truck carrying the steel tube observing platform runs.

The centre section of the telescope tube itself is a steel casing seven feet in diameter and weighing 5½ tons. Just above the lower flange, the casing swells out to eight feet seven inches to accommodate an iris diaphragm for use in stellar photography.

Construction of the diaphragm is similar on a big scale to that of the familiar small cameras. But the shutter of many cameras is less than one half inch aperture. The shutter of the Dunlap observatory camera opens to six feet, two inches. It is operated by a hand wheel.

Prof. Chant is enthusiastic on the possibilities of the new and development in the science of the heavenly bodies to be afforded by the new observatory.

OFFICE OF THE PRESIDENT
H. J. CODY, M.A., D.D., LL.D.

April 13, 1935

Mrs. D. A. Dunlap,
93 Highlands Avenue,
Toronto.

Dear Mrs. Dunlap:

The Senate of the University unanimously desires you to accept the honorary degree of Doctor of Laws at the special convocation to be held on the evening of Friday, May 31, in Convocation Hall.

You will be back in time to learn all the detailed arrangements about this ceremony.

With kindest regards,

Yours faithfully,

H. J. Cody

President.

Richmond Hill Telescope Largest in British Empire

Newly-Completed Mirror to Study Heavens Through Huge Lens

EXPOSE PLANETS

Toronto, April 26.—The largest telescope in the British Empire, at the Dunlap observatory Richmond Hill, Ont., is nearing completion Some night in the near future, Professor C. A. Chant and his associates will realize their fondest dreams when they begin delving the heavens through the giant 74-inch lens, presented to the University of Toronto by Mrs. D A Dunlap and her son, D. Moffat Dunlap

The monster mirror will be two inches larger than the one at Victoria, B.C. This, however, according to Prof. Chant, will not give an appreciable advantage They will, as a matter of fact, be virtually twins The position of the new telescope will place it 800 feet above sea level Besides being the largest in the British Empire it will be the second largest in the world, surpassed only by the 100-inch telescope at Mount Wilson in California

The mirror was cast June 21, 1933, at Corning N.Y., and was then shipped to England where it has been undergoing a delicate grinding and polishing The huge monocle is 74 inches in diameter, 12 inches thick at the edge and 11 inches in the center To ensure a perfect flawless mirror, the pyrex of which it is made, was poured at a temperature of 1,500 degrees centigrade or 2,700 degrees fahrenheit It was then allowed to cool to 900 degrees F. before it was placed in an annealing oven for three months while the temperature was minutely lowered.

"It was necessary to do this" said Professor Chant head of the department of astronomy at the University of Toronto and who will be in charge of the new observatory, "in order that it would show no strain or flaws It came out perfect."

Magnifies 40,000 Times

The mirror will have a magnification 40,000 times that of the human eye It will magnify to such an extent that cities the size of Toronto, Winnipeg, or Calgary would be clearly visible on the moon, if the moon had such cities. The Great Lakes, if the great orb had any, would be as plainly seen by the observer A freighter on the lake however, would not be seen Professor J. H. Hogg, a young scientist who was an attendant astronomer at the Dominion astrophysical observatory at Victoria and who came to Toronto to work on the new telescope shortly past cast the outline of a group of buildings such as the Canada in National Exhibition building or the University of Toronto might be seen, but he would not commit himself further.

There on the high ground north of Toronto, the astronomers will work, like salesmen during the Christmas rush, from sunset to dawn taking spectroscopic pictures of the heavens. Victoria has in the last 10 years taken and filed some 23,000 such photos. Nor will the scientists be the only ones to view the moon. In all probability the observatory will be opened to the public one night a week so that housewives and office workers may see the moon magnified 40,000 times.

Take Accurate Pictures

The observatory which has been under construction for the past four years is now awaiting installation of the mirror. The administration building of cut stone, provides space for offices, a library and for the laboratories necessary for accurate measurement of the photographic plates. The building which houses the telescope has a 61-foot dome weighing 80 tons and which rests on 24 rollers, each 27 inches in diameter. This permits rotation of the dome as the planets in the heavens shift their positions

Watching an object in the sky is not the easy job which may be imagined. Stars and all heavenly bodies are continually shifting, and it is necessary that the telescope be accurately pointed at the moving object. The difficulties encountered may be compared with the keeping of a gun pointed at a one-inch target twenty miles away while the target moves at the rate of five feet per second Movement of the image by only a thousandth of an inch while it is being photographed will make a serious defect in the resulting picture.

The value of a telescope during an eclipse of the sun is seen in the photographs it will permit which will show the leaping prominences of the corona. Telescopes have shown the prominences extending a distance of 567,000 miles. With the arrival of this mirror, the scientists enter the final stage of the work It is expected that the observatory will be formally opened on May 31, the 70th birthday of Prof. Chant.

North Bay Nugget Ont. April 26, 1935

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2 WEYMOUTH STREET
PORTLAND PLACE
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TORONTO UNIVERSITY TORONTO=

THANKS FOR MESSAGE GLAD NEWS CONGRATULATIONS SAILING EUROPA ELEVENTH
=JESSIE DUNLAP=

1834 1934 TORONTO CENTENNIAL CELEBRATIONS

IT'S HOME-COMING YEAR IN TORONTO

GIANT TELESCOPE SOON TO OPERATE

Moose Jaw Eve. Times. Sask. April 2, 1935

EMPIRE'S LARGEST LENS TO BE COMPLETE BY SPRING.

By EDWIN S. JOHNSON,
Canadian Press Staff Writer

Toronto, April 25 (CP) Since discovery of the wide orbit more than three centuries ago [illegible] have vastly yielded some of the profound secrets which through the ages British probing astronomy and in this march of investigation Canadian scientists have played an important role

Among this group is Dr A C Chant professor of astrophysics at the University of Toronto, who has devoted most of his life to the study of the mysteries of the skies, so the discovery of the new 74-inch mirror constitutes a triumph for science In its application there's a far more absorbing object the giant telescope which is being erected under the auspices of the Dunlap Memorial Observatory, at Richmond Hill, 15 miles north of Toronto.

The observatory is not only a monumental erected through the generosity of Mrs. Jessie D. Dunlap to the memory of her husband an amateur astronomer but fulfillment of a cherished dream for Dr Chant

It was back in 1907 that he laid the foundation of the present important department of astrophysics at the University and since that day he has looked forward to the time when he could be able to lend his name to wider scope of research with the aid of a powerful telescope But at the time he thought in terms of a more modest enterprise than the Dunlap 74-inch reflector which will be the largest working one in the British Empire

Transporting the Great Mirror

Toronto Honors Observatory Participants

Special to The Christian Science Monitor

TORONTO—The opening of the David Dunlap Observatory at Richmond Hill recently was concluded at the University of Toronto when honorary degrees were conferred upon six prominent participants in the earlier ceremony.

Degrees of doctor of laws (honoris causa) were conferred on Sir Frank Watson Dyson, former Astronomer Royal of England; Mrs. Jessie Dunlap, donor of the observatory; and Dr. C. A. Chant, director of the observatory. Doctor of science degrees (honoris causa) were conferred on Harlow Shapley, director of Harvard College Observatory; Vesto Melvin Slipher, director of Lowell Observatory; and W. E. Harper, acting director of the Dominion Astrophysical Observatory, and a former pupil of Dr. Chant.

It was announced that Dr. Chant would become emeritus professor of astrophysics, emeritus director of the observatory, and honorary librarian and director of publications at the observatory. Dr Chant graduated from the University of Toronto in 1890, returning the following year as a fellow in the department of physics, and since that time he has been connected continuously with the university.

The great telescope, the second largest in the world, was visualized as a means of studying double stars, analyzing the spectrum of the stars, photographing clusters and solving the problem of fragments by Dr. Shapley of Harvard Observatory. By the new observatory Canada joins the United States in making Western Hemisphere astronomy a thing for the future to think about, he said.

The need for greater observation and the study of distant planets was stressed by Dr. Slipher. Everyday uses of astronomy were outlined by Dr. Harper, who contended that a better understanding of it would eliminate superstitious fears.

Unloading the Mirror from the railway car to the truck.

Arriving at the Observatory.
Unloading from the truck to the Dome

May 2, 1935

UNIVERSITY OF TORONTO
TORONTO 5, CANADA
REGISTRAR'S OFFICE

May 14th, 1935.

Mrs. D. A. Dunlap,
93 Highlands Avenue,
Toronto.

Dear Mrs. Dunlap:

The President of the University has directed me to inform you that the University will, if you so desire, provide you with the academic costume to be worn at the Special Convocation on Friday, May 31st, including the cap, gown, and hood, and will ask you to accept the hood as a souvenir of the occasion. In this connection, perhaps you would be kind enough to call at the Registrar's Office, Simcoe Hall, at your early convenience in order that you may be fitted with cap and gown.

I enclose herewith an outline of the ceremony of conferring degrees as observed by the University of Toronto.

I shall be glad to receive from you a list of your friends to whom you would wish to send invitations for the official opening of the David Dunlap Observatory and the Special Convocation.

Yours very truly,

Registrar.

Abf:dw

UNIVERSITY OF TORONTO

THE CEREMONY OF CONFERRING HONORARY DEGREES

Each candidate for an honorary degree will wear the cap and gown appropriate to the degree which he is to receive, and will walk in procession to Convocation Hall where he will take the seat assigned to him upon the platform.

The presenter for each candidate, usually the President of the University, will rise and, after saluting the Chancellor, will deliver the presentation address. He will then formally present the candidate who will rise and advance to the Chancellor. The Chancellor will take the candidate's hand and confer the degree upon him, the Bedel placing the hood upon his shoulders.

The Chancellor will then request the candidate to sign the Golden Book. After having done so, the candidate will return to his seat.

1935 May 13

TELEPHONE: GREENWICH 2322
27, WESTCOMBE PARK ROAD,
BLACKHEATH, S.E.3.

Dear Mr Dunlap,

Prof Chant wrote to me that you have kindly invited me to stay with you when I come for the opening ceremony of the David Dunlap Observatory. He also gave me your address in London but when my wife and I called to day we found that you had already returned to Canada. We look the pleasure of meeting your

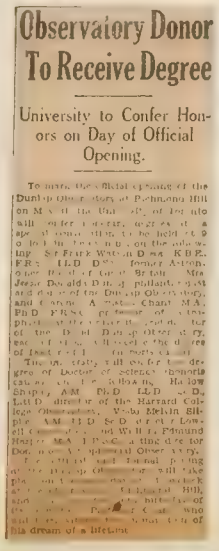
2

TELEPHONE: GREENWICH 2322
27, WESTCOMBE PARK ROAD,
BLACKHEATH, S.E.3.

go to a young naval officer and is expecting a baby early in June. She wishes to be remembered very kindly to you

I am leaving by the Lancastria on May 18 which should reach Montreal on May 24 and I shall come immediately to Toronto. I shall return by the Aquitania from New York which sails on June 7, so as to be in time for the Jubilee of

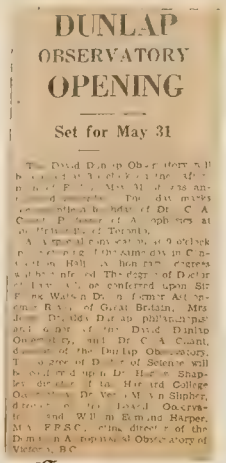
The Globe
May 11, 1935



Observatory Donor To Receive Degree

University to Confer Honors on Day of Official Opening.

To mark the official opening of the Dunlap Observatory at Richmond Hill on May 31 the University of Toronto will confer honorary degrees at a special convocation in connection with the ceremonies. The following will receive the degree of LL.D.: Sir Frank Watson Dyson K.B.E., F.R.S., LL.D., D.Sc., former Astronomer Royal of Great Britain; Mrs. Jessie Donalda Dunlap, philanthropist and founder of the Dunlap Observatory, and Dr. C. A. Chant, M.A., Ph.D., F.R.S.C., professor of astrophysics and director of the David Dunlap Observatory, and Dr. Harlow Shapley, A.M., Ph.D., LL.D., Sc.D., director of the Harvard College Observatory. Wesley Melvin Sillpie, A.M., LL.D., Sc.D., director of Lowell Observatory, and William Edmund Harper, M.A., F.R.S.C., acting director for Dominion Astrophysical Observatory.



DUNLAP
OBSERVATORY
OPENING

Set for May 31

The David Dunlap Observatory will be opened to the public on the afternoon of May 31, it was announced yesterday. The day marks the culmination of the gift of Dr. C. A. Chant, Professor of Astronomy at the University of Toronto.

A special convocation will be held in the morning in Convocation Hall, when honorary degrees will be conferred. The degree of Doctor of Laws (LL.D.) will be conferred upon Sir Frank Watson Dyson, former Astronomer Royal of Great Britain, Mrs. Jessie Donalda Dunlap, philanthropist and donor of the David Dunlap Observatory, and Dr. C. A. Chant, director of the Dunlap Observatory. The degree of Doctor of Science will be conferred upon Dr. Harlow Shapley, director of the Harvard College Observatory, Dr. Wesley M. Van Sinpher, director of the Lowell Observatory, and William Edmund Harper, M.A., F.R.S.C., acting director of the Dominion Astrophysical Observatory of Victoria, B.C.

The Mail and Empire
May 11, 1935

DUNLAP OBSERVATORY

BY CONRAD LEWIS

SUPPOSING there be a "Man in the Moon"—a supposition which your scientific star-gazers frown upon, by the way—there is a distinct possibility that you would be able to see his house through the new 74-inch telescope of the David Dunlap Memorial Observatory, now completed for the University of Toronto at Richmond Hill, ten miles from the city.

For such is the power of this enormous lens — at the moment largest in the British Empire and second largest in the world—that it annihilates stellar distances to a mere fraction of what they were, and brings within the field of human vision stars and heavenly bodies which must have forever remained beyond our sight. The moon, for instance, viewed through the Dunlap telescope, is less than sixty miles away. And what a mottled surface it presents, with its age-old craters and wrinkles!

At an estimated cost of half a million dollars for land, buildings and equipment — the last involving the lion's share of the expense—the David Dunlap Memorial Observatory has been reared to the memory of a citizen of Toronto who comparatively late in life became enthralled with the magic of the stars.

David A. Dunlap, Toronto mining lawyer and geologist, died in October, 1924. For a few years prior to his death Mr. Dunlap became interested in astronomy, so much so that he attended many lectures given by Professor C. A. Chant, head of the department of astrophysics, University of Toronto. Together they had often peered through the University's six-inch telescope—and while Mr. Dunlap gained a hint of the marvels to be revealed, he also learned of the notable and legacy of this instrument to pierce as but the nearest fringe of the heavens.

"How tiny are our instruments, in comparison with the Celestial Universe," cried El Karkali, Arabian astronomer, who built an observatory at Cairo in the twelfth century.

And two years after Mr. Dunlap's death, Professor Chant was echoing El Karkali sentiments, for in an interview in September, 1926 he said: "Of all the remarkable needs of the University I think the most outstanding is an astronomical observatory."

The year later came the announcement of Mrs. Dunlap's gift.

IN EAST AND WEST

ONE does not have to be an astronomer to appreciate the value of this addition to Canada's facilities for astronomical research. One does not even have to abate his interest in the latest hockey scores, or the football results, to grasp the fact that in the Dunlap Observatory, both the University of Toronto and Canada as a whole are greatly richer, in a scientific sense, than they were before the gift was planned.

The fruit of a suggestion made by Professor Chant to Mrs. Jessie Dunlap and her son, David M. Dunlap, the completed Memorial Observatory sets Canada the distinction of having two telescope of the largest class, for the instrument at the Canadian Government Observatory at Victoria, B.C., is only two inches less a diameter than the one just installed. Even if compared with the 100-inch reflector at Mount Wilson, California, for a few more years only to be the world's largest—either of Canada's sky-searching lens takes a respectable showing. Only if one remembers the enormous 200-inch 'monocle' recently cast for the California Institute of Technology, do the proportions of any of those now in existence begin to be dwarfed.

But look at it whatever way you like a 74-inch telescope is no mean investment and no mean gift. Figured either in cold cash or in the labor and skill and time involved in its fabrication, it is a monument alike to the donors and to mankind's ingenuity and patience.

For telescopes are not made in a hurry. This one at Richmond Hill, for instance, took close to five years in the making—due mainly to the profound care required in the casting and polishing of the mirror. True, it might have been set up sooner but for the change in plans which substituted an improved form of Pyrex glass for ordinary optical glass—but the fact remains that the contract for the telescope was given in May, 1930, and it was not until May, this year, that the finished "eye" was ready for its mounting.

POURING THE LENS

HAD you been in the Corning Glass Works, Corning, N.Y., on a summer's morning in 1933, you would have witnessed a strange rite. Awe-inspiring, too—for here was Dante's inferno reproduced.

A huge crucible spouts white-hot molten liquid. In a steady stream it pours into a mould on the floor of the foundry—and beats back the knot of spectators with its withering heat. An eerie glow is cast over the scene; there is the pungent odor always associated with searing flame. They are pouring the glass for the David Dunlap telescope.

Two and one-half tons of viscid terror, it lies there, slowly cooling. From 2,700 degrees Fahrenheit—the temperature of some of the cooler stars—in four hours it is down to 900 degrees Fahrenheit—which is still more than enough to brown your morning toast. Then to an annealing oven, where for four long months it is permitted to cool, a few degrees a day, by electric thermostatic control. This gradual cooling is essential, for otherwise the heavy mass might crack and split asunder.

At last it is ready to be touched by human hands. And now it lies revealed to those who had so long planned and watched, and, one feels, prayed. A rough disc of glass, six feet or more in diameter, twelve inches thick at the edges, and eleven inches in the centre. It is now ready to be ground and polished.

Grinding and polishing a sheet of glass? Most of us would dismiss the notion that this job presents untoward difficulties. It's easy!

And so it is—if you are careful to see that said glass is polished only for a few minutes at a time (in order that too much heat be not generated by the friction); that only the finest jeweller's rouge be used, and finally —and this is most important — that the result be a lens true in every detail to within 1-500,000th of an inch.

Shipped to England in October, 1933, for this last process, the reflecting lens has only just returned to Toronto for installation in its final resting place. Pronounced perfect after every test at the Derby works of the Parsons Optical Company, where it was finished, it is now ready to fulfil the fondest hopes of those who have looked forward to its completion.

Perhaps mention is due here to the special type of Pyrex glass employed in the making of the lens. A discovery of specialists at the Corning Glass Works three years ago, the improved Pyrex has this great advantage over ordinary glass—that its coefficient of expansion is much less. A mighty important detail when the least change of temperature registers an effect on the accuracy of the lens.

FOCUSSED BY FINGER

SIR WILLIAM HERSCHEL, when he built his first telescope late in the 18th century, regarded it as quite an achievement. And rightly so—for those days. Making visible half a million stars, taking the sky as a whole, his contribution to the science of astronomy has lost nothing with the passing of the years.

Just what he would have said of this 60-ton affair, its 29-foot tube piloted about its dome with little more than a finger touch, is something at which we can only guess. Of one thing we can be sure, however—and this is that he would have lost no opportunity to test its powers.

With an ease that would have amazed him, he would have turned the telescope this way and that; focussing it first, perhaps, on one of the planets, and then spanning greater voids, and pointing it at the stars, or one of those inconceivably distant star clusters. In all, he would bring more than a billion stars within reach, and thousands of those island universes occupying the attention of astronomers today.

He would have seen how clockwork—powerful yet built with the precision of a chronometer—so controls the movement of the telescope that its imperceptible turning neutralizes the rotation of the earth; permitting the lens to be focussed at will on a fixed point in the sky. Were it not for this "anti-earth" rotation, hours-long photography of a star would be impossible.

Which brings to mind the fact that 90 per cent of the observations to be made at the observatory will be by means of photography. As at Victoria, where in fifteen years they have assembled a file of 23,000 spectroscopic photos, Professor Chant and his collaborators will study the stars—their speed, temperature, candlepower, pressure, and so on — by recording the spectroscopically the light received from them. In most cases merely a pinpoint of light, it is true; but allowing for the magnification of the lens, plus the sensitivity of photographic film exposed for hours, your astronomer will get a pretty fair idea of the physical properties of stars. In fact, their character, behavior and antecedents will be bared to him.

A spectrum, it should be noted, is the rainbow result obtained when light is broken up into its constituent parts.

OTHER GIFTS TO SCIENCE

THERE are many precedents for Mrs. Dunlap's aid to astronomical research. Largely by United States citizens.

One of the most notable of these gifts is the Lick Observatory in California, founded about fifty years ago by James Lick, of San Francisco. Lick, though not himself an astronomer, had been deeply impressed with the marvels of the heavens at that time revealed, and he wished to advance the limited knowledge at that time available. The observatory is conducted by the University of California.

The Yerkes Observatory, of the University of Chicago, was provided by Charles T. Yerkes, a financial man of that city. It has also achieved distinction as a centre for astronomical study, and is a great monument to its founder.

At the Ohio Wesleyan University, located at Delaware, Ohio, the Hiram M. Perkins Observatory perpetuates the name of a professor of mathematics and astronomy who left his life savings, $100,000, to further the study of the sky. Professor Perkins died in 1926, and a 60-inch telescope has since been built.

Another example of practical interest in astronomy, although he never gave any indication of it in his lifetime, was furnished by W. J. McDonald, a merchant of Paris, Texas. Also in 1926, Mr. McDonald provided in his will for a million dollars to be given to Texas State University to establish an observatory.

Pittsburg and Oakland are two other American cities that have been favored with similar gifts. The former by Dr. John A. Brashear, a noted maker of lens and mirrors, and the other by Anthony Chabot, an Oakland citizen.

REVEALING THE UNIVERSE

BUILT on a 180-acre tract deeded to the University of Toronto, the David Dunlap Observatory commands a wide view of the surrounding countryside. Eight hundred feet above sea level—and 500 feet above the distant smoke haze of Toronto — the plant dominates the landscape both from the Toronto-Barrie highway, and from the C. N. R. tracks close by.

There is the administration building, with its three rust-red, copper-sheathed domes (in which will be mounted smaller telescopes) and a little distance away, the 61-foot dome housing the big instrument. It is planned that the grounds will be laid out as a public park, and also that the observatory will be open to the public on one night a week. Probably Saturdays.

Thus, to the idle curious, as well as to those whose interest springs from a deep-seated desire for knowledge, will be revealed parts of our universe that were old before the earth was in existence.

Beginning with the solar system, the spotlight will be thrown on our closest neighbor, Venus — a mere 26,000,000 miles away when nearest the earth. Mars and Mercury, each a few million miles farther out than the other, will also be brought within plain view. For what's a few million miles in stellar space? Nothing at all!

Pluto, outermost member of our sun's family of planets, and on y recently discovered both by reason of its small size and immense distance from the earth, is forty times more distant from the sun than we. And as every upper-grade schoolboy knows, the sun is a good deal farther away than we could travel in a lifetime railway trip. Ninety-three million miles, as a matter of fact.

But it's when we leave our tiny group of planets—and some of them are not so tiny compared to the earth!—that the imagination begins to get dizzy with the never-ending emptiness of outer space. Take the nearest star, Proxima Centauri, a faint star down in the southern hemisphere and not visible in Canada at all. Well, Proxima Centauri is four light-years distant; which, if one likes figures, is some 25,000,000,000,000 miles. Sirius, brightest star in the whole sky, is just twice as far, but gives 70,000 times more light than the other.

And beyond? Breath-taking as these figures are, they make no impression on the extent of the known universe. Star clusters, galaxies, nebulae, island universes, floating on and on through hundreds of millions of light-years of space—one can only stop here and wonder anew at the majesty, the marvel of creation.

Said Professor Chant recently—"I have no hesitation in saying that at least 90 per cent. of astronomers agree that the universe is not the result of any blind law, but is regulated by some great intelligence, force or power, call it what you will. There may be some, however, who believe the universe is the result of chance."

"It all depends on the individual."

observatory will enable Dr. Chant and his associates to come into intimate contact with heavenly bodies hitherto well-nigh inaccessible to human vision.

Built to the memory of a Toronto mining engineer and geologist, member of the Royal Astronomical Society of Canada—David A. Dunlap—the new observatory cost half a million dollars for land, buildings and equipment. Mr. Dunlap passed in October, 1924, but prior to that time he attended many lectures given by Prof. Chant before the Astronomical Society, becoming an enthusiast in the study of the science.

In 1927 Mrs. Dunlap expressed her intention of erecting the observatory to her husband's memory, but not until June of the following year was everything in readiness to call for the making of the necessary instruments. The original decision was to erect two buildings, a steel structure to accomodate a large telescope, and an administration building for office work and reduction of observations recorded. While the remainder of the work was going on, the huge telescope was ordered at once, as there was no means of telling when it would be completed. The mighty mirror forming the most important part of the telescope was, of course, the most difficult piece of construction of the entire project.

The site of the observatory was difficult to select. From 20 to 25 miles from Toronto was considered the limit of the distance from the city it should be located.

As most of the clear weather accompanies north or north-west winds, it was decided to build the observatory in that direction, after experiments to discover the transparency of the air at varying distances from Toronto and the amount of illumination in the sky had been undertaken. These experiments proved that places 30 and 35 miles distant were far better than those nearer the city, particularly with respect to sky-illumination.

Placed on High Ground

Finally it was decided to establish the site at a spot some 12 miles north of the city, nearly a mile east of Yonge Street on the highest spot in the neighborhood, near Richmond Hill, 800 feet above sea level, the ground sloping away on every side. The spot is nearly devoid of trees, and as in open places the sun's heat causes unstable atmospheric conditions interfering with the use of the telescope, it is planned to transform the land about the new observatory into an arboretum, to be called the David Dunlap Park.

Sir Howard Grubb, Parsons and Company, England, was the firm to which the contract to build the great telescope, the mounting, the optical portions and the steel buildings to house the telescope was awarded. This building was ordered in November, 1931, and on July 31, 1933, it was received in Toronto.

Completely built of steel, this building has a circular drum and a dome in the shape of a hemisphere lying upon it, both with double walls. At the base of the building is an open space to allow the entry of air, which flows upward to the top and is emitted through openings with baffle plates at the upper portion of the dome. A hard paper material, "agasote," covers the dome both inside and outside, while the latter has still greater armoring through copper sheeting.

It is thus that by day the place is kept cool, and by night, while open for observations, it becomes the same temperature as the outer air. There is thus no interference with the 'definition' of the telescope from heated currents of air, as there would be should heat in any quantity be stored in the walls.

Dome Weighs 80 Tons

Of about 80 tons in weight, the dome rests on 24 rollers, 27 inches in diameter, on a circular track. The whole dome may be rotated so as to permit the opening to face any section of the sky. At the top and base of the dome two parallel shutters run on rails and cover and uncover this opening. As the building cannot be heated on account of the air currents which would be actuated, the observers must be suitably clothed to withstand cold.

The building's chief occupant is the telescope, which is made up chiefly of the huge mirror and its mechanism for supporting it and pointing it toward the portion of the heavens to be studied.

A block of glass 76 inches in diameter and about one foot in thickness, the mirror weighs some 5000 pounds, necessitating a correspondingly heavy mounting so built that the telescope can be pointed toward any part of the sky and moved continuously by clockwork to follow any object from east to west as it passes across the heavens as a result of the rotation of the earth. The moving parts of the mounting alone weigh about 30 tons, yet the motion must be absolutely steady.

Manufacturers Limited

Although the telescope had been ordered in 1930, unforeseen difficulties arose which prevented its being proceeded with by 1932. In the former year, only a German and an English firm could manufacture large telescope mirrors. On this continent the Corning Glass Works of Corning, N. Y., had made some small "pyrex" disks of glass better by far than anything ever before made, but the firm was not prepared to attempt the manufacture of such a large disk as was required for this observatory.

Conditions changed, however, and it was planned to make a 200-inch telescope of pyrex glass. The Corning Glass Works installed the furnaces and annealing ovens necessary, and on June 21, 1933, the Toronto disk was poured from a special type of pyrex.

After the huge disk had come from the annealing oven late that September, it was shipped to England to be ground and polished, a task which it was estimated would take 18 months, because of the frailty and weight of the glass, and the high degree of accuracy to which the surface had to be shaped. The finished mirror arrived on May 2, and after the removal of several of the steel plates from the wall of the building, leaving a nine-foot gap, it was got inside and mounted.

Office Accommodations

The second structure, the administration building, provides suitable accommodation for office space for the staff, for study of the plates taken with the telescope and for the direction of the work of the observatory. Built of stone along classical lines, it is located about 200 feet from the dome, and on its roof appear three domes to house similar instruments.

The library of the observatory is also housed in the administration building. The Royal Astronomical Society of Canada has loaned the more technical portion of its library to the observatory for three years.

The research plans of the new observatory are to be carried on photographically. During a year it is estimated that there are about 125 clear nights having 1200 hours of observation. During all these hours, from sunset to sunrise, the giant telescope will be in use either for direct photography of portions of the sky or in the use of auxiliary instruments as, for example, the spectroscope for securing the spectra of the stars.

No New Theories

As Dr. Chant put it during the interview, he and his staff do not go out to work upon any special new theories. The work accomplished will be photometric and spectroscopic. From a study of the spectrum a great amount of extraordinary information is secured, and Dr. Chant said that he intended starting from that point. On the bottom of the telescope there is a spectrograph instrument, and by means of photographs spectra of the sky or stars will be photographed and studied.

By means of the spectrum it is possible to tell the material of which a star is composed, he told us, the rate at which it is approaching or leaving the earth, how far it is away and many other details. The photometric side of the research problem covers measuring the brightness of stars and how the light is distributed in the little lines of the spectrum.

And the object of all this research, of course, is to study the universe.

To Co-ordinate Studies

It will be some months before it is possible to begin any routine study, said Dr. Chant, as the new instrument is so immense. Dr. Chant's course will not be to study any specific portion of the sky, but to find out what other astronomers are at work upon, and to co-operate with them. It is possible that the new instrument will be able to identify certain stars others have not distinguished.

Dr. Chant keeps closely in touch with astronomers in a number of countries. He intends to attend the international meeting in Paris in July of this year. By keeping in touch with these men and learning their plans, he is able to extend co-operation.

"I think there is greater co-operation between astronomers than among members of any other branch of science," he declared.

The Saturday Night
May 18, 1935

The Christian Science Monitor.
Boston. May 31, 1935

At the Official Opening
May 31, 1935

Hon. D. Marshall, Lieut-Gov. Bruce, President Cody, Mrs. Dunlap, Dr. D. B. Macdonald.

Mr. A. S. Mathers presenting the Golden Key to Mrs. Dunlap

UNIVERSITY OF TORONTO

ORDER OF PROCEEDINGS

AT THE PRESENTATION TO THE UNIVERSITY
AND THE OFFICIAL OPENING
OF THE

DAVID DUNLAP OBSERVATORY

BY

JESSIE DONALDA DUNLAP

MAY 31st, 1935

New Observatory At Toronto Has Huge Telescope

Mrs. Dunlap Donor of Astrophysical Plant to Honor Husband

Special to The Christian Science Monitor

TORONTO, May 31—The David Dunlap Observatory, housing the second largest telescope in the world, was formally opened today when Mrs Dunlap, the donor, opened its door with a key of gold. She then presented the building and its equipment to Dr. Bruce MacDonald, Chairman of the Board of Governors of the University of Toronto, the president of which, Dr. H. J. Cody, presided at today's ceremony.

Dr. Herbert A Bruce, Lieutenant Governor of Ontario, conveyed the greetings of the province Greetings were also brought by Cyril Young of Newcastle Eng., representing the firm which had the task of building the big tele-cope, Sir Frank Dyson, former astronomer royal of England, Prof Harlow Shapley of the Harvard Observatory, Prof. H D. Curtis, Observatory of the University of Michigan, and Dr W E. Harper, Acting Director of the Dominion Astrophysical Observatory, Victoria, B. C.

For many years it had been the purpose of Dr C. A Chant, professor of astrophysics at the university, to have an observatory and undertake definite research into the knowledge of astronomy as a department of the institution Today, on his seventieth birthday, he realized that ambition when he received charge as its director of one of the greatest astrophysical institutions of the world, having at the present time the second largest telescope in the world

Interviewed by The Christian Science Monitor, Dr. Chant described some of the mechanism he will use in the new observatory and explained the work upon which he will be occupied in the future

The new 76-inch telescope of the

(Continued on Page 3, Column 7)

The Chancellor, the President, the Governors and the Senate
of the
University of Toronto
request the honour of your presence
at the
Official Opening of the David Dunlap Observatory
at Richmond Hill
on Friday, May 31st, 1935, at 3 p.m.

R.S.V.P.
The Registrar,
University of Toronto

Invitation to the Opening

The Opening of the Observatory, May 31, 1935

Listening to the Addresses

Going to the Great Dome

President Cody and Rt. Hon. W. L. M. King

Dr. Cody Speaking

Dr. Bruce Speaking

Mrs. D. A. Dunlap

The President
of the University of Toronto
requests the pleasure of your company at
Dinner
on... Friday May 31. at 7.30 p.m. sharp
Faculty Union, Hart House
in honor of recipients of honorary degrees.
R.S.V.P.
President's Office

UNIVERSITY OF TORONTO

SPECIAL CONVOCATION

FOR THE CONFERRING OF

HONORARY DEGREES

ON THE OCCASION OF THE
OFFICIAL OPENING OF THE
DAVID DUNLAP OBSERVATORY

FRIDAY, MAY 31st, 1935

A. J. Cody
F. W. Dyson
Robt. A. Falconer
W. Mackenzie King
Harlow Shapley
Duncan [illegible] Arthur
H. H. Langton
S. H. Needler
J. Burgon Bickerstaff
W. E. Harper
O. A. Gagé
C. A. Chant
[illegible]
[illegible]
[illegible]
F. J. N. Hoffman
H. Zemmell
C. Young
Leopold Young
[illegible]
Mary D. Curtis
[illegible]
Jessie D. Dunlap

Those at the Dinner

The Mail and Empire June 1.

Dunlap Observatory, Largest in Empire, Is Formally Opened

Outstanding Astronomers Attend Ceremony as Giant Telescope Is Presented as Memorial to U. of T. — Unflagging Effort Climaxed

TORONTO, through the University of Toronto, and by the generosity of Mrs. Jessie Donalda Dunlap, was virtually given the freedom of the heavens and elevated to rank among the world's foremost cities of science with the dedication and formal opening of David Dunlap Observatory, Richmond Hill, yesterday afternoon.

Before a crowd of more than 1,000, gained inclement weather, the astronomers of this country and Great Britain Mr. Dunlap officially opened and formally presented her memorial to her late husband to the University of Toronto. Received by Dr. D. B. MacDonald, Chairman of the Board of Governors, it was in turn placed under the charge of Professor C. A. Chant, who will be its director.

Seventieth Birthday.

Coincident with the formal opening of the observatory, which houses the largest telescope in the British Empire, was Dr. Chant's seventieth birthday anniversary. The astronomer, who has been a leading figure in the world of astronomy for many years, received congratulations from all parts of the world.

In the afternoon the world's second largest observatory, the David Dunlap Observatory, Richmond Hill, was formally opened and dedicated.

A notable gathering of scientists and scholars joined a crowd of about 1,000 to witness the ceremony over which Dr. R. J. Cody, president of the university, presided. Mrs. Jessie Donalda Dunlap, the donor, was unable to be present owing to illness, but was represented by her daughter, Mrs. Isabel Dunlap Bickford, who handed the keys of the magnificent building to Dr. Cody. Dr. Cody in turn presented the keys to Dr. Brice M. Meredith, chairman of the board of governors of the university, who accepted the gift on behalf of the university and appointed the university's trustee to it.

Dr. Cody read messages of congratulation from Sir James Jeans, Sir Arthur Eddington from the Royal Astronomical Society of Canada, and from the Astronomical Union of North America.

Sir Frank Dyson, former Astronomer-Royal of England, was personally present to receive the medal of the Royal Astronomical Society of England. He said that the new observatory presented the University of Toronto with a magnificent opportunity for research. The great 74-inch reflector telescope and the site on which it was placed were beautiful, he said.

His Honor Dr. Herbert A. Bruce, Lieutenant - Governor of Ontario, stated that the observatory was to be regarded not only as a gift to the University of Toronto but also to Ontario indeed to Canada. Mrs. Dunlap, he said, had done a tremendous service to the university by her princely gift.

IN TOUCH WITH INFINITY

Professor H. D. Curtis, director of the University of Michigan Observatory, remarked that astronomy brought us in touch with infinity.

Seated on the platform in front of the administration building round which the crowd semi-circled, were Rt. Hon. the Lieutenant-Governor, His Honor the Lieutenant-Governor, Rt Hon Mackenzie King, Sir Frank Dyson, former astronomer-royal of England; Professor H. D. Curtis, director of the University of Michigan Observatory; Prof. H. Shapley, director of Harvard College Observatory; W. E. Harper, acting director of the Dominion Astro-Physical Observatory; Sir Hubert Young, general manager of Sir Howard Grubb, Parsons and Company, England.

Presented by Mrs. Dunlap.

Mrs. Dunlap, in presenting the observatory to the University of Toronto, briefly stated the gift was in loving memory of her husband and an expression of his interest in astronomy. She hoped through the equipment that great advances would be made through research work in astronomy.

Dr. Bruce Macdonald, chairman of the board of governors, who received the key, reminded those present that the telescope pointing toward the sky was indicative of a great deal of the man in whose memory it was being donated. "He was always a searching for the truth; he was a hearted and generous to those in need. Above all things, he whose memory is enshrined here, was full of the 'milk of human kindness,'" a great need in the world to-day," said Dr. Macdonald.

Every portion of the mirror had been worked out in theoretical contour to two one-millionths of an inch, said Cyril Young, who explained the evolution of the big mirror. 76 inches in diameter, 12 inches thick and weighing 5 000 pounds. He modelled how it had been poured from a special type of pyrex by the Corning Glass Work, put into the annealing oven and sent to England to be ground and polished.

President H. J. Cody was in the chair. A. S. Mathers, of Mathers and Haldenby, architects, presented the golden key to Mrs. Dunlap. Messages of congratulation and greetings were read from Sir James Jeans, Sir Arthur Eddington, the Astronomical Union of North America, the Royal Astronomical Society of Canada.

The Globe, June 1, 1935

Crowd Looks on As Big Telescope Is Bared to View

1,000 Guests Watch in Awe as Observatory Opened.

AT RICHMOND HILL

Presented to University as Memorial to David Dunlap.

A great hemispherical dome of 80 tons surfaced with copper, yesterday rotated about the top of a circular stone structure. Two parallel shutters slid open and the mammoth 74-inch telescope that is to unfold the secrets of the heavens hove into view. A thousand invited guests looked on with awe as the telescope moved about pointed to the skies. The David Dunlap Observatory was ready to study the mysteries of astronomy.

Situated on a hill-top 800 feet above the sea-level overlooking a vast expanse of countryside that suggested something of the limitless possibilities of the explorations of the telescope in the decades and centuries to come, the David Dunlap Observatory was opened yesterday afternon at Richmond Hill with a golden key, by its donor, Jessie Donalda Dunlap, as a memorial to her husband.

Leading students of the heavens, amateur scientists, outstanding educationists, representatives of the church and state, and men and women prominent in various walks of life, gathered to triumph in the opening of the world's second largest observatory with the greatest telescope in the British Empire. Dr. C. A. Chant, director of the observatory, who for three decades had looked forward to this moment and who was celebrating his 70th birthday, evidenced the pride that was bursting within him as he saw the culmination of his dreams

The opening ceremonies were conducted in the open air at the steps of the handsome, two-story, grey-stone administration building, a stone's throw from the copper dome which revolves about the telescope, and were presided over by Principal H. J. Cody.

In the presence of Lieutenant-Governor Herbert A. Bruce, Right Hon. Mackenzie King, Sir Frank Dyson, former Astronomer-Royal of England; Sir Robert Falconer, Hon. Duncan Marshall, and many other luminaries seated on the platform, the dedicatory prayer was read by Rev. E. W. Wallace, Chancellor of Victoria College.

Handed Golden Keys.

Mrs. Dunlap was then handed the golden keys to the building, which she opened and entered. Speaking quietly and with emotion, she handed the keys to Dr. Macdonald, saying: "In loving memory of my husband David Alexander Dunlap, I now present this astronomical observatory to the University of Toronto, believing this memorial will express his deep interest in astronomy and hope through its equipment great advances will be made in the science."

Dr. MacDonald's response carried a sincere tribute to David Dunlap, whom he described as a man who "was always looking up to the heavens searching out the higher things in life. A man who was courteous, open-minded, open-hearted and ever ready to help a worthy cause.

"Not great in the eye of the public, he accomplished many things in his lifetime, and above all things he was full of the milk of human kindness, and that is what we need in the world today," Dr. MacDonald said.

Speaking on behalf of the Province, the Lieutenant-Governor stated that Mrs. Dunlap, through her magnificent gift, was rendering a service not only to the university, but also to the people of Ontario and indeed to Canada.

"The wonder of man's mind is never so graphically revealed as when the astronomer sets out to plot the measureless space and plumb the infinite," he said.

Dr. Chant Praised.

Bringing with him a message of congratulations from the Council of the Royal Astronomical Society of England, Sir Frank Dyson spoke in tribute of the abilities of Dr. Chant and his staff which includes Dr. R. K. Young, Dr. Frank Hogg and his wife, Dr. Helen Hogg, and Dr. P. M. Millman. The Royal Astronomical Society of Canada was organized in Toronto largely through the efforts of Dr. Chant, he said.

"From the Dunlap Observatory will come building blocks in the picture we are trying to make of infinite worlds outside," Prof. H. D. Curtis, director of the University of Michigan, Ann Arbor, stated in a brief address.

Prof. Harlow Shapley, director of the Harvard College Observatory, at which Dr. Chant's staff obtained their degrees, complimented Mrs. Dunlap and also Dr. Chant on "the pretty trifle he has received for a birthday present." By it Canada joins with the United States in "making Western Hemisphere astronomy a thing for the future to think about," he said.

Others who spoke briefly were Cyril Young, General Manager of Sir Howard Grubb-Parsons and Company, Newcastle-on-Tyne, manufacturers of the giant telescope, and W. E. Harper, acting director of the Dominion Astrophysical Observatory, Victoria, B.C.

Messages Read.

Dr. Cody read many messages of congratulation and good wishes from throughout the world, among them being those of the Astronomical Union of North America, the Royal Astronomical Society of Canada, and from Sir James Jeans and Sir Arthur Eddington, foremost English astronomer.

Following the ceremony, Mrs. Dunlap was hostess to the large gathering at a reception on the lawn of the administration building. And for several hours people streamed in and out of the telescope building, where the details of its construction were explained to them, and the great dome, 61 feet in diameter, manipulated to revolve back and forth on its large casted rollers.

Two shutters, 16 feet wide, run vertically through its centre and open on tracks at top and bottom. Through this opening the great telescope is directed toward any desired position in the heavens.

The Star, June 1.1935

HUGE TELESCOPE DEDICATED MRS. DUNLAP GIVEN DEGREE

Scientists See Enlargement of Soul in Increase of Knowledge of Infinite

PRAISE FOR CHANT

With the sun smiling its greeting, the David Dunlap Memorial Observatory was formally dedicated to the University of Toronto yesterday afternoon by Mrs. Jessie Donalda Dunlap when she turned a gold key in the door of the administration building before 1,000 guests. The largest in the British Empire and second only to that in California, the huge reflecting telescope will enable scientists to reach realms of space hitherto unexplored by Canadian astronomers.

Mrs. Dunlap, dedicating the observatory, said: "I recall and express the deep interest of my husband in astronomy." She hoped it would help to advance the science as she turned the key to open the building.

"It will be a memorial to future generations. 'It is something well worth while,' declared Dr. Bruce Macdonald, chairman of the board of governors, accepting the gift on behalf of the University of Toronto. "It points to the sky like David Dunlap, who was always looking up for more truth," he said. "He accomplished great things." E. W. Wallace, president of Victoria college read the dedication prayer. Deeply moved, Mrs. Dunlap kept her eyes on her program.

Delayed when his car was caught among hundreds of automobiles, Lieutenant-Governor Bruce arrived as the crowd rose to sing the national anthem.

Broadcast from coast to coast in the afternoon, a recording of the ceremonies was made on Ottawa and broadcast in the evening over nation-wide networks in the United States.

Rev. H. J. Cody, president of the university, was chairman and read telegrams of congratulations from the Royal Astronomical Society of Canada, Astronomical Union of North America, Sir James Jeans, one of the leading astronomers of the world and author of "This Mysterious Universe," Sir Arthur Eddington.

Bruce Gives Thanks

"This observatory will always be regarded not only as a gift to the University of Toronto but as one to Ontario and to Canada," declared Dr. Herbert Bruce "We are deeply grateful to Mrs. Dunlap. "To bring the heavens nearer is second only to bringing heaven nearer. It makes easier attempts to wrest celestial secrets from the skies," he said, in paying tribute to Dr. Chant and his assistants. "It will help to launch our minds into infinity and will enable men to reap a richer harvest from the heavens of contemplation.

Declaring that the opening day was deliberately chosen to coincide with the 70th birthday of Dr. C. A. Chant, head of astronomy and astrophysical departments at the university, Dr. Cody called on him to speak. Stating that he had been dreaming of this day for 30 years, Dr. Chant said that it was nothing to the decades in which work will be done there "bringing honor and distinction to the land." Dr. Chant said the corner stone was laid in September, 1932, and praised David Dunlap, with whom he had discussed the idea nearly 10 years before. "Mrs. Dunlap shares fully her husband's tastes and friendship with the stars," he said. "To her all credit is due. This creation is acclaimed as beautiful and appropriate, a miracle of mechanism." He acclaimed his colleague Dr. R. K. Young.

Dr. Harlow Shapley, director of Harvard Observatory, said that the only [illegible] place where there was similar interest in astronomy was in South Africa, and then only outsiders went there because of the suitability of the climate.

"You have us beaten by two inches," laughed W. E. Harper, acting director of the Dominion Astrophysical Observatory at Victoria "but we are not envious. The starry heavens above and the moral law within make real the Supreme Being. There are no limitations."

Get Degrees

At a special convocation in Convocation hall last night, the honorary degree of Doctor of Laws was conferred upon Sir Frank Dyson, former astronomer royal of England Mrs. Jessie Donalda Dunlap, and Dr. C. A. Chant. Degrees of Doctor of Science were conferred on Dr. Harlow Shapley, director of the Harvard college observatory, Dr. V. M. Slipher, director of the Lowell observatory, and W. E. Harper, director of the Dominion astrophysical observatory.

The Rt. Hon. W. L. Mackenzie King, recovered from his recent illness, announced that it had been his intention to attend the convocation "without being seen in Toronto or missed at Ottawa" to pay a special tribute to all those who contributed to the realization of the construction and completion of the observatory.

"This is not only a great day for the university and a great day for this country but also a day of remembrance for the whole scientific world," declared Mr. King. "I did not come here for relaxation or recreation, but for inspiration. The completion of this noble work is a great inspiration."

He warmly extolled Mrs. Dunlap for her contribution. The Richmond Hill astronomical centre, he said, was a combined monument, resembling a double star which seems to be as one, to the generosity of the sponsor and the memory of her husband. He also lauded the unflagging enthusiasm and determination of Professor Chant.

"Science, unlike virtue is its own reward," quoted Dr. Chant in his speech of thanks to Dr. H. J. Cody. "Thirty years ago I suggested to my colleagues that because astronomy was a neglected department in the university curriculum, a small section devoted to astrophysics should be established. But I never dared to dream that such an inconspicuous beginning should be so fruitful. I predict with the greatest confidence that the present staff of the observatory will soon place it in the forefront of world astronomical bases."

Canadians Prominent

Sir Frank Dyson, speaking for himself and also on the behalf of Mrs. Dunlap, thanked the university and said the university was especially endeared to him for the part it played in keeping alive his sister as a result of the medical triumphs of Drs Banting and McLeod. "It has been especially noticeable to me that prominent Canadian astronomers seem to come only from Toronto. The reason is obvious — Professor Chant,' he said

Stressing that although the observatory was finished its problems had not begun, Dr. Shapley humorously condemned the universe for being so uncooperative with researchers. "I wish omnipotence would clean up the milky way of cosmic debris," he laughed. Four problems, he thought, should be tackled by the new unit. They were: the study of double star orbits, analysis of star spectrums, star clusters, examination, and the recording of the movements of the fragment universe.

Dr. Harper affirmed that the rudiments of astronomy should be a necessary part of the intellectual equipment of the ordinary man "If only to free the public mind from the mediaeval belief in horoscopes and astrology and rid people from this wide spread gullibility. It would be valuable," he said. Dr. Slipher expressed appreciation and wished the new unit success.

Professor W. A. Burton, head of the department of physics, presented Sir Frank Dyson for the degree, complimented Mrs. Dunlap and also Dr. Chant on "the pretty trifle he has received for a birthday present." By it Canada joins with the United States in "making Western Hemisphere astronomy a thing for the future to think about," he said.

Others who spoke briefly were Cyril Young, General Manager of Sir Howard Grubb-Parsons and Company, Newcastle-on-Tyne, manufacturers of the giant telescope, and W. E. Harper, acting director of the Dominion Astrophysical Observatory, Victoria, B.C.

Messages Read.

Dr. Cody read many messages of congratulation and good wishes from throughout the world, among them being those of the Astronomical Union of North America, the Royal Astronomical Society of Canada, and from Sir James Jeans and Sir Arthur Eddington, foremost English astronomer.

Following the ceremony, Mrs. Dunlap was hostess to the large gathering at a reception on the lawn of the administration building. And for several hours people streamed in and out of the telescope building, where the details of its construction were explained to them, and the great dome, 61 feet in diameter, manipulated to revolve back and forth on its large casted rollers.

Two shutters, 16 feet wide, run vertically through its centre and open on tracks at top and bottom. Through this opening the great telescope is directed toward any desired position in the heavens.

The Telegram, June 1, 1935

Degrees Follow Opening Of Dunlap Observatory

Noted Scientists and Scholars Join in Event at U. of T.—Six Are Honored

A special convocation held [illegible] the Dunlap observatory was formed conclusion to a memorable day for the University of Toronto yesterday.

Earlier in the afternoon the world's second largest observatory, the David Dunlap Observatory, Richmond Hill, was formally opened and dedicated.

A notable gathering of scientists and scholars joined a crowd of about 1,000 to witness the ceremony over which Dr. H. J. Cody, president of the university, presided. Mrs. Jessie Donalda Dunlap, the donor, was unable to be present owing to illness of her husband who handed the keys of the magnificent building to Dr. Cody. Dr. Brice M. Meredith, chairman of the board of governors of the university, accepted the gift on behalf of the university and appointed the university's trustee to it.

Dr. Cody read messages of congratulation from Sir James Jeans, Sir Arthur Eddington from the Royal Astronomical Society of Canada, and from the Astronomical Union of North America.

Sir Frank Dyson, former Astronomer-Royal of England, was personally present to receive the medal of the Royal Astronomical Society of England. He said that the new observatory presented the University of Toronto with a magnificent opportunity for research. The great 74-inch reflector telescope and the site on which it was placed were beautiful, he said

His Honor Dr Herbert A Bruce, Lieutenant - Governor of Ontario, stated that the observatory was to be regarded not only as a gift to the University of Toronto but also to Ontario indeed to Canada. Mrs. Dunlap, he said, had done a tremendous service to the university by her princely gift.

IN TOUCH WITH INFINITY

Professor H D Curtis, director of the University of Michigan Observatory, remarked that astronomy brought us in touch with infinity, things that enlarge the soul and ennoble the spirit

"Astronomy," he said, "is the science that makes science religious."

Professor Harlow Shapley, director of the Harvard College Observatory, humorously referred to three members of the University of Toronto's astronomical staff—Dr. Peter Millman, Dr. F. S. Hogg and Dr. Helen Hogg—who were "doctored" under me supervision at Harvard

"If the become obstreperous," he said, "let me know and I'll give them some more medicine

"This is a pretty trifle that Dr. Chant has received for a birthday gift." Dr. Shapley continued. "It occurs to me that he will be rather costly for future birthday presents."

COST OF $500,000

The observatory, which Dr Chant officially took over yesterday, was erected at a cost of $500,000.

Dr. Chant himself told how Mrs Dunlap readily fell in with his suggestion that she should erect an observatory to the memory of her husband, who was a keen amateur astronomer. He paid a full-hearted tribute to Mrs Dunlap for her sympathy and generosity.

Others who spoke at the afternoon's session were W. E. Harper, acting director of the Dominion Astrophysical Observatory at Victoria, B.C., and Cyril Young, general manager of Sir Howard Grubb, Parsons and Company, the firm which constructed the telescope

Among those who were present were Rt Hon. Mackenzie King, Sir Robert Falconer, Sir Joseph Flavelle, Hon. Newton Rowell, Hon. Vincent Massey, Hon Duncan Marshall, Mr. Justice Masten, His Worship Mayor James Simpson, and deans of faculties and heads of departments in the university.

DEGREES CONFERRED

In the evening the honorary degree of doctor of laws was conferred upon Mrs. Dunlap, Dr. Chant and Sir Frank Dyson, and the honorary degree of doctor of science upon Profe ior Harlow Shapley, W. E. Harper and Profe or V. M. Slipher, director of the Lowell Observatory.

Dr. Shapley suggested four problems that the new observatory would be in a position to attack—the motion of double stars, how they revolve one about the other, from which something could be learned about the structure of stars; the analyses of the spectra of stars; the motion of clusters of stars like the Pleiades and Hercules; and the study of fragments, of shooting stars and asteroids.

Mr. Harper stated that a rudimentary knowledge of the stars would rid us of gullibility, of superstitions which include a belief that comets presage the end of the earth and a belief in horoscopes and the influence which planets exert over one's destiny.

The convocation ended with a short address by Rt. Hon Mackenzie King

"This has been a great day," he said, "not only for the university but for our country."

English Scientist Doubly Indebted

Double thanks were given to the University of Toronto last night by Sir Frank Dyson, former Astronomer-Royal of England.

Sir Frank was among other distinguished scientists who received an honorary degree from the University with the formal opening of the David Dunlap Observatory yesterday.

After thanking the University for conferring the degree of Doctor of Laws upon him, Sir Frank said: "I am also indebted to Toronto for a great medical discovery. My sister must have had her life prolonged 10 years by the discovery of Banting, Best and McLeod."

The Telegram

Six Honorary Degrees Given by University

Professor Chant, Mrs. Dunlap and Visiting Astronomers Honored.

Six prominent participants in yesterday's opening of the new David Dunlap Observatory, last night wore scarlet gowns of distinction conferred on them by the University of Toronto.

Degrees of Doctor of Laws (honoris causa) were conferred on Sir Frank Watson Dyson, former Astronomer-Royal; Jessie Donalda Dunlap, donor of the observatory and Clarence Augustus Chant, director of the observatory, and prime mover of the project, Doctor of Science degrees (honoris causa) were conferred on Harlow Shapley, director of Harvard College Observatory; Vesto Melvin Slipher, director of Lowell Observatory, and William Edmund Harper, acting director of the Dominion Astrophysical Observatory and a former pupil of Professor Chant.

Announcement was made that Dr Chant who graduated from the University in 1890 and returned as a fellow in the department of physics the following year, and who has been connected continuously with his alma mater since that time, would become emeritus professor of astronomy, emeritus director of the observatory and honorary librarian and director of publications at the observatory.

Sir Frank Dyson spoke for himself and on behalf of Mrs Dunlap. He pointed out that he had had a special sentiment for the University of Toronto inasmuch as the discovery of Banting, McLeod and their associates had prolonged the life of his sister.

Among those on the platform were Rt. Hon Mackenzie King, His Honor Rt. Hon. Herbert A Bruce Dr J. J. Tompkins, minister of education in Dunbert McArthur, deputy minister and [illegible] Simpson, president Cody Major Simpson acted as chancellor in the absence through illness of Sir William Mulock, chancellor.

The Mail and Empire June 1,1935

The New York Times, Sat. June 1, 1935

NEW OBSERVATORY OPENED AT TORONTO

Gift of Widow in Memory of Husband, It Contains World's Second Largest Telescope.

APERTURE OF 74 INCHES

Prominent Canadian, American and British Astronomers Attend Ceremony of Dedication.

By JAMES STOKLEY.

Special to THE NEW YORK TIMES.

TORONTO, May 31.—Equipped with the world's second largest telescope, a reflector seventy-four inches in aperture, the David Dunlap Observatory of the University of Toronto was opened at Richmond Hill near here this afternoon.

Several hundred guests, including Canadian, American and British astronomers and government officials, saw Mrs. Dunlap, who gave the observatory as a memorial to her husband, receive the keys from the architects, and, after opening the door to the administration building, turn the observatory over to Dr. D. B. MacDonald, chairman of the university's board of governors.

In introducing Dr. Clarence A. Chant, director of the observatory, the Rev. H. J. Cody, president of the university, said today had been chosen for the ceremonies because it was the seventieth birthday of Dr. Chant, who had sought such an observatory for years.

Dr. Chant revealed that in 1921, following a lecture on a comet then visible, he had mentioned the possibilities of such an observatory. Afterward Mr. Dunlap introduced himself and expressed interest in the project. Though he died in 1924, his widow later decided to give the project in his memory.

Ordered From England.

The great telescope was ordered from Grubb, Parsons & Co. at Newcastle-on-Tyne, England, in 1930. After it proved impracticable to have the large glass disk for the mirror made in England, it was ordered from the Corning Glass Works of Corning, N. Y., and was made of material similar to that used in the 200-inch disk now cooling which will ultimately form the eye of the great telescope of the California Institute of Technology.

The disk was sent to England, where it was ground and figured at the Parsons works.

In addition to Dr. Chant, addresses were made by Dr. H. A. Bruce, Lieutenant Governor of Ontario; Cyril Young, general manager of Grubb, Parsons & Co.; Sir Frank Dyson, former Astronomer Royal of Great Britain; Dr. H. D. Curtis, director of the University of Michigan Observatory; Dr. Harlow Shapley, director of the Harvard College Observatory, and Dr. W. E. Harper, acting director of the Dominion Astrophysical Observatory.

At a special convocation this evening, honorary degrees of LL. D. were conferred on Mrs. Dunlap, Sir Frank Dyson and Dr. Chant, and honorary Sc D. degrees on Dr. Shapley, Dr. Harper and Dr. Vesto M. Slipher, director of the Lowell Observatory, Flagstaff, Ariz.

Away From City's Smoke.

The observatory consists of two buildings erected on a hill twelve miles north of Toronto, where the prevailing winds, from the northwest, will blow the smoke from the city in the opposite direction.

The Administration Building, surmounted by three domes to contain smaller telescopes, contains the offices, library and computing rooms. The 74-inch telescope is housed in a circular steel building, over which is the large rotating dome, weighing eighty tons. The moving parts of the telescope weigh thirty tons, and, while they can be moved electrically, are so perfectly balanced that they can be operated by hand.

Dr. R. K. Young, Professor of Astronomy in the university, estimates that during the normal year about 125 nights will be satisfactory for observations, with 1,200 observing hours. Practically the entire time of the telescope will be used for photographing the heavens, either directly or through the spectroscope, to determine the motions of the stars and the intensities of the various lines in stellar spectra.

Completion of this telescope gives Canada the second and third largest telescopes in the world. The 72-inches at the Dominion Astrophysical Observatory, Victoria, had previously held second place. Within two years, however, the 82-inch reflector being built in Cleveland for the MacDonald Observatory of the University of Texas will be completed, and possibly by 1940 the 200-incher in California will be searching the skies.

The world's largest telescope at present is the Carnegie Institution's 100-incher at Mount Wilson Observatory, California.

Topical Wide World Photo.

NEW OBSERVATORY OPENED IN CANADA. The gift of Mrs. David Dunlap, which was turned over yesterday to the University of Toronto as a memorial to her husband. The building houses the second largest telescope in the world.

The Literary Digest
June 15, 1935

Toronto's Telescope

In 1921, Prof. Clarence Augustus Chant, in one of his popular astronomy lectures at Toronto, declared that Eastern Canada needed a large telescope. Out of the crowd, at the conclusion of the address, stepped David Alexander Dunlap, wealthy geologist and mining lawyer, to inquire what such a telescope might cost.

Three years later, Mr. Dunlap died. His widow decided, in 1926, to build an observatory, dedicating it to his memory. A fortnight ago, Professor Chant's fourteen-year-old dream of a fine mirror for the stars at Toronto came true, on his seventieth birthday. With Professor Chant, as Director, routine observation of the stars began last week at David Dunlap Observatory of the University of Toronto.

The observatory's seventy-four-inch reflecting telescope is the largest in the British Empire, eclipsing the huge reflector of the Dominion Astrophysical Observatory at Victoria, British Columbia, by two inches. It was made at Newcastle-on-Tyne, England, by the British firm of Grubb, Parsons & Co., but is not all-British. the glass disk for the mirror was cast at Corning, New York, of the same low-expansion type of material as that used in the disk for the forthcoming 200-inch telescope of the California Institute of Technology.

The David Dunlap Observatory also has a nineteen-inch reflecting telescope, made by Dr. R. K. Young, Associate Director and Professor of Astronomy at the University. The large reflector is exceeded in size by only one telescope in the world, the 100-inch at Mt. Wilson Observatory. It will remain second in size for several months, pending completion of the eighty-two-inch telescope of the McDonald Observatory of the University of Texas, to be finished next year.

Keystone

Dr. C. A. Chant

Professor Chant will retire at the end of June from his professorship at Toronto, to devote his time to the observatory. He joined the University staff in 1891, became Professor of Astrophysics in 1918. He has been Editor of *The Journal of the Royal Astronomical Society of Canada* since 1907.

At seventy, he bears a strong resemblance to John D. Rockefeller, Sr., as he was in his middle age: his nose is long, lips narrow, eyes deeply set. His hobbies are boating and fishing, but in a life devoted almost entirely to astronomy he never has taken much time to enjoy them.

The work of the new observatory has been planned for several years. It will consist of studies of the velocities, temperatures, and densities of stars.

Saturday Night, June 8th.

OPENING THE DUNLAP OBSERVATORY. This group includes Cyril Young, general manager of the British firm which built the telescope, Prof. C. A. Chant, director of the Observatory (who was also celebrating his 70th birthday), Principal E. W. Wallace of Victoria College, the Rt. Hon. W. L. Mackenzie King, and (behind at right), A. S. Mathers, of the architect firm of Mathers & Haldenby, which designed the structure.

—Photographs by "Law"

TORONTO

"THE fault, dear Brutus, is not in our stars, but in ourselves, that we are underlings," so it is not surprising that we are becoming more astronomically-minded to know our stars better and thus better understand ourselves in this age of research. Mrs David Dunlap's magnificent memorial gift in memory of her husband—the greatest Observatory in the British Empire—has uplifted our eyes to something beyond the passing show. It also brought the most noted astronomers to Toronto—Sir Frank Dyson, himself, the former Astronomer-Royal at Greenwich, was Mrs. Dunlap's guest. And it is remarkable enough to repeat here the comment by a very wonderful old lady aged ninety-six years of age, when she heard of the occasion. Fancy one's grandmother at the age of 96 quoting to me Addison's *Ode*, word perfect! "The spacious firmament on high, with all the blue, ethereal sky, and spangled heavens, a shining frame, their great Original proclaim. Soon as the evening shades prevail, the moon takes up the wondrous tale, and nightly to the listening earth repeats the story of her birth, while all the stars that round her burn, and all the planets in their turn, confirm the tidings as they roll, and spread the truth from pole to pole. Forever singing, as they shine, the hand that made us is divine." I think that must be one of the finest of the first tributes that Mrs. Dunlap's great gift inspired—a woman of 96 quoting a poem of the seventeenth century.

And it was that sort of a really memorable occasion—timeless—when Dr. Bruce Macdonald as chairman of the Board of Governors of the University, accepted this deed of gift which Mrs Dunlap had opened with a golden key and presented in a charming manner with a few well-chosen words. That magnificent set of buildings will be certain to attract society as well as scientists to astronomy—they defy a layman's description but His Honor, Dr. Bruce, quoted some very appropriate phrases in contemplation and President Cody's appreciation was but a prelude to Convocation ceremonies when Mrs Dunlap was the one woman among the distinguished astronomers to be honored with the honorary LL D and to attend Dr. Cody's Convocation dinner at Hart House.

* *

PROFESSOR CHANT, who on this his 70th birthday was realizing the hopes of a lifetime, was a centre of attention too, he sat with several United States astronomers and the British Columbian Dominion Director, Mr. W. E. Harper; and the official platform at the façade of the administration building blazed with luminaries of this planet who did the orbit of the tea-tent most humanly later. Sir Frank Dyson, whose quarters in the Greenwich Observatory were just nearby the site of that great Wolfe-Montcalm commemoration that was a unique Canadian occasion a couple of years ago, was involuntarily making star gazers out of tea-drinkers with his charming enthusiasm for his hobby. And star-scattered on the grass, guests were quite literally turning down empty cups in their haste to cheer or observe the Observatory.

Mr. Mackenzie King had come all the way from Ottawa, but Oxford and exams prevented Mr Moffat Dunlap to be present at the opening of this wonderful memorial to his father. Two favorite relatives of Mrs Dunlap there were Mrs. Ray Hodge and Mrs R. L. Blackburn, of Ottawa, and Mr Donald Gunn who is a brother of Mrs Moffat Dunlap, brought his lovely wife, who was formerly Miss Anne Osler. Her frock, cerise and violet flowered, was topped with a cerise hat. Mrs Herbert A Bruce had golf-tonelets of floral tone on her black ensemble. Mrs H J Cody and Mrs D Bruce Macdonald were busy ones with wide, shady hats and Mrs Riddell, with Mr Justice Riddell were a massive Gainsborough-clesh one. Mr J H McConnell wore a pretty pastel one too, Mr Justice Masten wore one of the few grey toppers, pretty Mr George Hees had a tabo hat, Mr. E A Dunlap came with her aunt, was escorted by her son, Mrs Vincent Massey, escorted by her husband, wore a most becoming brown ensemble and the Chief Justice, Sir William Mulock, was most missed—his daughter, Mrs Arthur Kirkpatrick, was explaining that he really was not ill. Mr Mathers and Major Haldenby, the architects, both wore a paternal air as they surveyed their prodigy. Professor R B Thomson, the botanist had momentarily turned his thoughts to sky-blue fields instead of meadows and Dr W H Lowry, the painist, was framing his own vision this time on the distant spectrum. So one and all were high-minded and it was an unforgettable occasion.

* *

MRS DAVID DUNLAP, the donor of the magnificent David Dunlap Observatory which was presented to the Toronto University in memory of the late David Dunlap.

SIR FRANK DYSON, the noted Astronomer, former Astronomer-Royal (right) snapped with Mrs. Vincent Massey, Mrs Dunlap and the Hon. Vincent Massey at the opening of the David Dunlap Observatory.

OBSERVATORIES ARE WINDY PLACES. His Honor, Dr Bruce, President Cody, and Mrs Dunlap at the Dunlap Observatory opening.

—Phot by "Law"

1935 June 7

ON BOARD
CUNARD WHITE STAR
"AQUITANIA"

Dear Mr Dunlap,

I owe you an immediate letter for your most kind hospitality. But I shall send a fuller one later on I did not see Mr David Milligan but saw the assistant Manager. They were most kind and let me have a row - which they did not charge for. Schlesinger - the Yale Professor - had sent a young Columbia Professor named Eckhart to meet me. I took him

The David Dunlap Observatory, Toronto

ALTHOUGH most of the astronomers of Canada are graduates of the University of Toronto, hitherto the University has possessed no observatory. This want has been recently supplied by the munificence of Mrs. D. A. Dunlap, who has presented the University with a 74-inch reflecting telescope, as well as a handsome administrative building. The inauguration ceremony took place on May 31, the chair being taken by the president of the University, Canon Cody, in the presence of the Lieutenant-Governor, Dr. Bruce, Sir Robert Falconer (a former president of the University), Mr. Mackenzie King (a former Prime Minister of the Dominion), professors of the University, and astronomers from Great Britain, Canada and the United States, and a thousand interested visitors.

After a dedicatory prayer by the Rev. E. W. Wallace, Chancellor of Victoria College, the chairman read letters of congratulation from the president of the International Astronomical Union, the president of the Royal Astronomical Society of Canada, Sir James Jeans and Sir Arthur Eddington. He then called on the architect, who handed a golden key to Mrs. Dunlap. She opened the door with the words, "In loving memory of my husband, David Alexander Dunlap, I now present this astronomical observatory to the University of Toronto, believing this memorial will express his deep interest in astronomy, and I hope through its equipment great advances will be made in the science", and handed the key to Dr. B. M. Macdonald, chairman of the Board of Governors.

After a warm expression of thanks by Dr. Macdonald, a sincere tribute to Mr. Dunlap was paid by him and by the Lieutenant-Governor. The president then called on Prof. Chant, the director of the Observatory, and noted that the inauguration had been fixed on Prof. Chant's seventieth birthday. Prof. Chant referred to Mr. Dunlap's great interest in astronomy, and said that in 1926 he ventured to lay the project of an observatory in Mr. Dunlap's memory before her. The foundation stone was laid in 1932 by Mr. Moffatt Dunlap. "To Mrs. Dunlap all the credit is due; were it not for her there would be no observatory here."

Mr. Cecil Young, manager of the firm of Sir Howard Grubb, Parsons and Co., then gave an account of the large telescope and dome which were described and illustrated in an article in NATURE of October 14, 1933. Sir Frank Dyson gave the good wishes of the Royal Astronomical Society, and congratulated Prof. Chant on the great interest in astronomy in Canada, which was in large measure due to him. Short addresses were given by Prof. H. D. Curtis, director of the Observatory of the University of Michigan, Prof. V. Slipher, director of the Lowell Observatory at Flagstaff, Prof. H. Shapley, director of the Harvard College Observatory, and Dr. W. E. Harper, director in charge of the Dominion Observatory at Victoria.

The Observatory is situated in 160 acres of ground on Richmond Hill, some twelve miles north of Toronto, from which a beautiful view extends in all directions. It is sufficiently distant from Toronto to avoid smoke and glare, and yet near enough to the University. The number of good observing nights is estimated at about 120 in the year. The administration building is a handsome structure of stone, surmounted by three domes for smaller telescopes. It contains office and computing rooms, a library and well-equipped workshops. The large telescope is in a steel dome with the necessary insulating material to diminish changes of temperature, and was constructed by Messrs. Sir Howard Grubb, Parsons and Co. The general appearance of the telescope in relationship to the dome is very satisfactory. The clockwork and the electrical movements of the telescope and dome fulfil all requirements. The mirror of 74 inches is of pyrex, made by the Corning Company of New York. The grinding and figuring of the mirror were carried out at Newcastle, under Mr. Cyril Young's direction, by Mr. Armstrong, the very competent artist of the firm. The spectroscope was constructed by Messrs. Adam Hilger, Ltd., and is admirably adapted to determine velocities in the line of sight for which the instrument will be generally used. Telescope and spectroscope were thoroughly tested by Mr. R. K. Young. In Mr. Young, Mr. Hogg and Mr. Millman, Prof. Chant has an able, experienced and enthusiastic staff. We may look with confidence for an excellent output of work from the David Dunlap Observatory.

F. W. DYSON.

Montreal Herald, June 7, 1935

PUBLIC SPIRIT IN TORONTO

SOME [illegible] philanthropist of the nation [illegible] ... millionaire ... [illegible] ... Toronto, where great [illegible] ... [illegible] ... placing that city in [illegible].

The newest benefaction in which the Queen City rejoices is the David Dunlap Observatory, which contains the second largest telescope in the world. It is a gift to the Canadian people from the late David A. Dunlap and was dedicated as a memorial to him.

"The second largest" we learn, from a contemporary, "is a word of great imperfection. The mirror is 73 inches in diameter, and will [illegible] ... while the entire telescope has a weight of 53 tons ... the power of this great telescope is astounding, it being 300,000 times as powerful as the unaided human eye. Faint objects millions of light years distant become plainly visible."

* * *

THERE are some people today who think that because charity ought to begin at home ... [illegible] ... and friendless, it ought to end there.

We consider that [illegible] ... to be ... to his native city the world ... [illegible] ... largest telescope.

No gift ... that will enhance the ... of man's mind and teach him to ... [illegible] ... we call Earth.

To our men of wealth and ... the interest of this city at heart we pass the suggestion along.

Not that we advise them all to buy observatories.

But no man who has more money than he needs should pass through this life ... without contributing to the health of the human body or ... the happiness of human mind.

Wealth is a ... when ... [illegible] ... function is still to serve others.

The Globe
June 1, 1935

CANADA'S NEW OBSERVATORY.

The Canadian public—at least that large section of it not greatly interested in astronomy—may be surprised to learn that yesterday, at Richmond Hill, the largest observatory in the British Empire, and the second largest in the world, was formally opened. This splendid contribution to the Dominion's scientific equipment has been made possible by the generosity of Mrs. Jessie Donalda Dunlap, at whose expense it has been erected and presented to the University of Toronto in memory of her husband, the late David Dunlap.

A pleasing incident connected with the ceremonies yesterday was that Dr. C. A. Chant of the university staff, who is to be Director of the observatory, was celebrating the seventieth anniversary of his birth. With the excellent equipment now at his command for study of astronomical phenomena, Dr. Chant will be a happy man. He has devoted the best years of his life to this study, and has attained high rank among the world's astronomers.

In this connection it should be noted also that another Canadian who has won renown in the realm of astronomical research work is John Stanley Plaskett, who supervised construction and erection of the 72-inch telescope on Little Saanich Mountain, on Vancouver Island, B.C. As Director of the Dominion Astrophysical Observatory, to which this great reflector belongs, Dr. Plaskett has been honored by universities and scientific bodies.

Astronomy is one of the oldest of man's studies. Early in the world's story observatories were founded in Eastern countries. The first observatory in Europe was erected at Nuremberg in 1472. Now all countries have up-to-date telescopes, by means of which man is adding to his knowledge of heavenly bodies. In America the Yerkes Observatory at Williams Bay, Wis., and the Lick Observatory, in California, are regarded as among the best in the world; though a 200-inch telescope being constructed for the California Institute of Technology will give a field many times greater than any other. In the neighborhood of Vesuvius there is an observatory for the special study of volcanic action. In England privately owned observatories carry on important work, and these indicate the keen interest of the individual in astronomical research.

In view of the universal nature of astronomical study, it is worthy of note that Canada will, with the addition of this observatory at Richmond Hill, be well to the fore. The donor, Mrs. Dunlap, is to be commended for her generosity in making possible this addition to the Dominion's standing in the world of science, and the University of Toronto must be congratulated on its opportunity to take a leading part in work aimed to provide for mankind more intimate knowledge of "the mysterious universe."

Christian Science Monitor
June 6, 1935

U. of T. to Lose Dr. C. A. Chant

Will Retire at End of June — Professor R. K. Young to Succeed

Dr. C. A. Chant, professor of astrophysics and director of the David Dunlap Observatory, retires from the University of Toronto at the end of the present academic session in June as he has reached the retiring age.

He will be succeeded by Professor R. K. Young, at present professor of astronomy in the University.

The announcement was made at the special convocation last night when Dr. Chant, among others, received an honorary degree from the University.

The day was a red-letter day for Dr. Chant. It was the 70th anniversary of his birth, the David Dunlap Observatory was formally opened before a distinguished assembly, and his Alma Mater conferred upon him the highest degree in its power.

Dr. Chant, when he retires, becomes emeritus professor of astrophysics, emeritus director of the observatory, honorary librarian and director of publications. He joined the staff of the University in 1891 as a fellow and through the years progressed to the highest office in the department. Speakers at the convocation last night paid tribute to him as one whose efforts were largely responsible for the interest and development of astronomy not only in Toronto but throughout the Dominion.

New Observatory Opened

Many Guests Attend Ceremony At Richmond Hill, Ontario

A great hemispherical dome of 80 tons surfaced with copper, rotated about the top of a circular stone structure. Two parallel shutters slid open and the mammoth 74-inch telescope that is to unfold the secrets of the heavens hove into view. A thousand invited guests looked on with awe as the telescope moved about pointed to the skies. The David Dunlap Observatory was ready to study the mysteries of astronomy.

Situated on a hill-top 800 feet above the sea-level overlooking a vast expanse of countryside that suggested something of the limitless possibilities of the explorations of the telescope in the decades and centuries to come, the David Dunlap Observatory was opened at Richmond Hill, Ontario, with a golden key, by its donor, Jessie Donalda Dunlap, as a memorial to her husband.

Leading students of the heavens, amateur scientists, outstanding educationists, representatives of the church and state, and men and women prominent in various walks of life, gathered to triumph in the opening of the world's second largest observatory in the British Empire. Dr. C. A. Chant, director of the observatory, who for three decades had looked forward to this moment and who was celebrating his 70th birthday, evidenced the pride that was bursting within him as he saw the culmination of his dreams.

Every portion of the mirror had been worked out in theoretical contour to two one-millionths of an inch, said Cyril Young, of England, who explained the evolution of the big mirror, 76 inches in diameter, 12 inches thick and weighing 5,000 pounds. He recalled how it had been poured from a special type of pyrex by the Corning Glass Works, put into the annealing oven and sent to England to be ground and polished.

The New Outlook, June 12, 1935

Canada's Greatest Observatory

THERE was general congratulation on the occasion of the opening of the David Dunlap Observatory at Richmond Hill near Toronto, Friday, May 31st. The huge seventy-four-inch telescope is the largest in the British Empire and second largest in the world. The observatory is the gift of Mrs. D. A. Dunlap and the occasion was fittingly accompanied by the conferring of the degree of doctor of laws on the donor and also on the distinguished Professor of Astronomy, Dr. C. A. Chant, who is director of the observatory and the prime mover in the great project which has just been brought to so successful a conclusion. Prof. Chant has now reached his seventieth year and will become professor emeritus. Other distinguished scholars were honored with similar degrees. It is hoped that the new telescope will stimulate study of the stars and will assist in the development of astronomers similar to those who have made this department in the university so well and so favorably known.

Journal of the Royal Astronomical Society of Canada, 1935.

Plate VIII.

Before the Administration Building.
C. A. Chant F. W. Dyson R. K. Young

Plate VI.

After the Formal Opening.
Sir Frank Dyson Mrs. Dunlap Mr. John B. Holden

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Plate V

Mrs. Dunlap Opening the Door of the Observatory

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Plate VII.

Within the Great Dome.
The spectrograph attached to the mirror cell of the 74-inch telescope is seen.

From the Journal of the Royal Astronomical Society of Canada
Sept. 1935

THE OPENING OF THE DAVID DUNLAP OBSERVATORY

By F S H and H S H

With Plates II—IX

I

The Ceremony in the Afternoon

On the afternoon of Friday, May 31, 1935, occurred an event of major importance in the annals of Canadian astronomy. On that date the David Dunlap Observatory was formally opened, and presented to the University of Toronto by the generous donor, Mrs Jessie Donalda Dunlap.

Three years earlier, on September 10, 1932, the corner stone was laid by Lady Eaton for David Moffat Dunlap. During the intervening years Lady Eaton's home just south of the village of Richmond Hill, about twelve miles north of Toronto, has been a scene of constant activity. First, the magnificent office building was constructed, then the giant dome for the seventy-inch mirror was erected within it the massive mounting of the telescope was installed. In Corning, N.Y. on June 21, 1933, was cast the 74-inch paraboloidal glass in Newcastle-on-Tyne, England, the largest piece of optical glass in the world, was ground to the correct figure by the firm which built the 200-inch glass of the Mount Palomar telescope. On May 2, 1935, the finished mirror was received at the observatory and on May 7, the day after it was tested, it was placed in its cell and next day [illegible] the tube of the telescope.

Actual work on the observatory started on the site of the observatory [illegible] but the project had been in the mind of the donor for many years. It was in 1927 that Professor Clarence Augustus Chant. For years he had considered that the University of Toronto might be the [illegible] observatory which should become one of the [illegible] of the astronomical world. Early in the [illegible] Mrs. Dunlap had expressed his interest in the [illegible] memory of her husband, the untimely death Mrs. Dunlap indicated her [illegible] establishment of the observatory as a memorial to her [illegible] largest telescope in the British Empire came into [illegible].

[illegible] May 31 1935 was especially selected for the formal [illegible] Professor Chant reached the age of seventy [illegible] to various astronomers, members of the [illegible] Astronomical Society of Canada and govern- [illegible]. Except admission was not restricted to formal [illegible], and interested members of the general public were [illegible] invited. About 1800 people were present.

[illegible] greetings were received from a large part of Canada and [illegible] States, those coming from the greatest distances in- [illegible] Dr. H. Spencer Jones, Astronomer Royal from Greenwich, England, Mr. Cyril [illegible], Astronomer Royal for Scotland, Edinburgh from Newcastle-on-Tyne, Eng- [illegible] A. M. Shapley from Flagstaff, Arizona, and Dr. W. E. [illegible] Victoria, B.C.

[illegible] platform on the east side of the Administration Build- [illegible] the trees to the building served as the speakers' [illegible] and were seated on the other side by chairs for many of the [illegible] and those connected especially with the ob- [illegible]. Towering clouds of the morning had disappeared, leaving [illegible] May in full glory of warmth and cheerfulness to the open- [illegible].

The exercises began at 3 o'clock with the entrance of His Honour, the Lieutenant-Governor of Ontario, and lasted an hour and a half. At their conclusion the huge shutters of the dome were opened, and the building thrown open for inspection. The Administration Building was decorated with apple blossoms, and the offices of Prof. Chant and Prof. Young were gay with large bouquets of spring flowers sent by Mrs. Dunlap. Refreshments were served in a marquee on the east side of the building, through the kindness of Mrs. Dunlap. Members of the observatory staff were stationed throughout the observatory to answer questions and demonstrate the [illegible].

Fig. 1—Two views of the opening of the Observatory.
Below—President Cody reading messages of congratulation.
Above—After the formal ceremonies.

The opening ceremonies were broadcast in the afternoon, and also recorded and rebroadcast over leading Canadian and United States stations in the evening.

The ceremonies commenced with the singing of the National Anthem on the arrival of His Honour, the Lieutenant-Governor of Ontario, Dr. Herbert Bruce. The President of the University, the Honourable and Reverend H. J. Cody, presided, and called upon the Reverend E. W. Wallace, President of Victoria College, to read the prayer of dedication. As the audience stood, Dr. Wallace spoke as follows:

O Lord, our Lord, how excellent is thy name in all the earth, who hast set thy glory upon the heavens. When we consider thy heavens, the work of thy fingers, the moon and the stars which thou hast ordained; what is man that thou are mindful of him, and the son of man that thou visitest him? Yet thou hast made him but little lower than thyself, thou makest him to have dominion over the works of thy hands.

Thou hast set us in a vast dwelling place and hast given us minds and hearts curious and patient, daring and skilful to search out the secrets of thy universe and to make it our home. And thou thyself art with us in that search. Thy Spirit is the inspiration of all scientists and poets, all dreamers of dreams and explorers of thy heavens.

For all those who in the past have thus studied to extend man's knowledge of thee and of thy handiwork, we offer to thee our humble and hearty thanks.

More especially this day we pray thee to accept our grateful thanks for this undertaking now brought to its completion.

For her, whose purpose and noble gift made possible these buildings and all that they contain,

For him, whose memory is here enshrined for ever;

For the vision of those who planned and for the skill of those, in this and other lands, who with patience and devotion wrought to realize that vision;

For the assistance of thy Spirit in bringing that purpose and thought and all that manifold activity to their perfect consummation;

We praise and glorify thy name, O God.

And now, we would dedicate to thee and to the service of mankind these buildings and these instruments, that they may ever be used for the extension of man's knowledge of thy truth. Grant, we beseech thee, that those who labour here may be guided by thy Spirit out into new and untrodden paths, in all humility and reverence, as children seeking to understand the mind and the heart and the works of their father, knowing that as they search for new light, that light itself is already coming to meet their search.

O thou, who art the light of the minds that know thee, the life of the souls that love thee, and the strength of the hearts that serve thee; grant that in this place and throughout our university true knowledge may grow from more to more, that the light of truth may be shed abroad in our city and our province, in our land and in all lands. Help us and all men by thy Spirit so to know thee that we may truly love thee, so to love thee that we may fully serve thee, whom to serve is perfect freedom. And this we ask through Jesus Christ, our Lord.

Amen.

The key to the Observatory was handed to Mrs. Dunlap by Mr. A. S. Mathers of the firm of Mathers and Haldenby, the architects who designed the building. This key was beautifully wrought of gold. On one side was embossed the crest of the University and on the reverse side was engraved Mrs. Dunlap's name and the date of presentation. With this key Mrs. Dunlap opened the main door of the Administration Building. She then presented the Observatory to the University, represented by Dr. D. Bruce Macdonald, Chairman of the Board of Governors, with the words,

"In loving memory of my husband, David Alexander Dunlap, I now present this astronomical observatory to the University of Toronto, believing that this memorial will express his deep interest in astronomy, and I hope through its equipment great advances will be made in the science."

Dr. Macdonald, in accepting the gift of the Observatory, reminded those present that the telescope, pointing toward the sky, was indicative of a great deal of the man in whose memory it was being donated. David Dunlap was always looking upward, searching for the higher things of life. He was a man of gentle manner, courteous to others, open-minded and open-hearted, ever ready to help a worthy cause. Though he was not great in the eye of the general public, yet he accomplished many things in his lifetime. Above all things he was full of the milk of human kindness, and that is something which is greatly needed in the world to-day. The Observatory would stand as a memorial to future generations, substantial, well worth while.

President Cody stated that a large number of greetings had been sent to Dr. Chant and to the University by various scientific organizations and leading representatives of various sciences. Of these, he read a number to the assembly, some of which were as follows:

From Sir Arthur Eddington *Cambridge, England* (Cable)

Wishing great success to the new telescope.

(*Signed*) Eddington.

From Sir James Jeans, *London, England*

Thank you so much for your letter and invitation. I am so sorry I shall not be able to be present at the opening of the telescope.

Unfortunately the end of May is precisely the time at which I find it impossible to leave my various appointments in this country.

I need hardly tell you that I wish you all good luck and success with the new telescope.

(*Signed*) James Jeans.

From Professor Frank Schlesinger, *Yale University, New Haven, Conn., President of the International Astronomical Union* (Telegram).

On behalf of the International Astronomical Union I congratulate you and the University on the opening of the David Dunlap Observatory. We wish for the observatory, and confidently expect, a long career of usefulness in furthering the progress of our science.

(*Signed*) Frank Schlesinger, *President.*

From R. A. Gray, B.A., *General Secretary of the Royal Astronomical Society of Canada*

The Council of the Royal Astronomical Society of Canada extend to the President and Board of Governors their congratulations and good wishes at the completion of the buildings and of the telescope presented by Mrs. D. A. Dunlap in memory of her husband.

It is our desire to place on record our satisfaction and recognition of the munificent donation of Mrs. Dunlap to the realm of Astronomy, with the earnest hope and confident expectation that it will be a means of extensive scientific development through the Department of Astronomy in the University of Toronto.

(*Signed*) R. A. Gray, *General Secretary.*

[*Further congratulatory messages received by Professor Chant appear at the end of this account of the official opening.*]

Addresses by Distinguished Persons.

President Cody then called on several of the distinguished men present to address the gathering.

His Honour the Lieutenant Governor of Ontario

I am confident that the expression of thanks of Dr. Bruce Macdonald is most warmly and enthusiastically seconded by everyone present. Mrs. Dunlap has indeed rendered a tremendous service to the University of Toronto by donating so munificent a gift. I am sure, too, that I shall be but voicing the sentiments of the citizens of this Province when I say that this Observatory will always be regarded not only as a gift to the University of Toronto but as one to Ontario—and, indeed, to Canada. May I therefore seize this welcome opportunity to assure Mrs. Dunlap that the citizens of Ontario are deeply grateful to her for having equipped the astronomers and scientists of Canada with so magnificent an instrument. I most heartily congratulate them upon their good fortune. To bring the heavens nearer by magnifying the stars is in all probability second only to bringing heaven nearer, and it must be most gratifying for them to know that from now on their attempts to wrest from the skies those celestial secrets computable only in terms of multi-millions and infinite infinities, will be made easier as vision becomes easier—thanks to Mrs. Dunlap and this Observatory.

Perhaps the wonder of man's mind is never so graphically or so dramatically revealed as when an astronomer sets out to chart limitless space, dropping the plummet of his intelligence down fathomless canyons of darkness or finding his way along ultimately immeasurable avenues of light. In the act of expressing to Mrs. Dunlap the pleasure and pride and grateful appreciation of the citizens of Ontario and in congratulating also the University of Toronto upon receiving so splendid a gift I would like also to pay tribute—all too inadequate tribute I fear—to the intellectual power, the patience and the zeal by which the gentlemen who study the heavens have already succeeded in laying bare to our awestruck gaze so many of the wonders and so much of the illimitable grandeur of this our own and other universes.

One day an astronomer who was speaking of his work quoted such figures and spoke of such dimensions when describing other stars and constellations of stars that by comparison our little earth appeared to be nothing more than a midge spinning out its brief day in the light of a million, million suns. The astronomer was thereupon approached by a man, who in philosophic tone and with an airy wave of his hand, remarked "It would seem that astronomically speaking man is somewhat less than nothing." "My friend," replied the astronomer, "astronomically speaking man is the astronomer."

No words of mine could convey so charming, so adequate and at the same time so well-deserved a compliment to astronomers and their work. We have with us a most distinguished assembly of them. I gladly make way for them to speak to us, as only astronomers can speak of the very instruments by which they are enabled to launch their minds quite literally into infinity.

I know Mrs. Dunlap's magnanimity in placing at their disposal this great observatory must have awakened in them sensations very like those the young poet John Keats experienced when he wrote.

"Then felt I like some watcher of the skies
When a new planet swims into his ken."

May this Observatory enable them to detect the intrusion of any and every new planet in order that they may reap an ever richer harvest of knowledge from the heavens of their contemplation.

The chairman then called upon Professor Chant to give some account of the history of the observatory.

Fig. 2—Two views at the opening ceremony.
Left—Professor Chant addressing the gathering.
Right—The visitors proceeding to the dome to see the great telescope.

Professor C. A. Chant, *Director of the David Dunlap Observatory*

I propose to make a brief historical statement regarding the David Dunlap Observatory, and hope I shall be pardoned if I begin by repeating a story which I related at the laying of the corner-stone on September 10, 1932.

In accordance with astronomical calculation, a comet known as Pons-Winnecke's appeared in the sky in the spring of 1921. This comet was discovered by Pons in 1819 but was not seen again until 1858 when Winnecke rediscovered it. Its successive returns were then carefully observed, since it was found that, owing to the attraction of the planet Jupiter, its period and distance from the sun were continually changing. As a consequence it was predicted that the comet might actually collide with the earth on July 1 1921. Special interest was thus aroused in this celestial visitor. In order to illustrate how the earth and the comet were coming together I constructed a model which I showed at a lecture delivered in the Physics Building of the University during the latter part of May. At the end of the lecture I took ten minutes to make a plea for an astronomical observatory for the University and the city, and I threw on the screen some slides to indicate the nature of the project. I may say that these were prepared some years before in connection with a scheme in which it was intended that the city, the Royal Astronomical Society of Canada and the University would unite. After the lecture a gentleman came up to me and said he was interested in my project. He said his name was David Dunlap. In the months which followed I had some correspondence with Mr. Dunlap regarding astronomical matters and he used to come to the meetings of the Astronomical Society. I cherished the hope that he might provide the observatory, but he passed away in the autumn of 1924. Two years after this, in December, 1926, I wrote to Mrs. Dunlap and recounted how I had met her husband and referred to the pleasant relations I had with him. I stated that I had hoped that Mr. Dunlap would provide the observatory, but, now that he had gone, I ventured to ask if she could consider the project as a memorial to her husband. The response was cordial and I was invited to visit her after the busy Christmas season. In January 1927 I called, and then found that Mrs. Dunlap shared fully her husband's tastes and was on friendly terms with the stars.

As no public action on the project could be taken for three years, we spent our time quietly, though profitably, in locating a suitable site and in gathering information regarding equipment. My colleague, Dr. Young, and I would study a large-scale contour map of the country within fifty miles of Toronto and would then explore the places we had selected. When we had found a possible site Mrs. Dunlap would inspect it. Well do I remember driving up yonder lane on a sunny afternoon in June 1928, parking the car near the old barn, clambering through a barbed-wire fence and walking to the top of the hill on which we now are. "This is the site," she said. As a matter of fact we examined many other sites but found none which we considered as satisfactory.

In May 1930 the order was given for the great telescope; we knew it would require three years for its construction. Then on September 10, 1932, the corner-stone of the Administration Building was laid by David Moffat Dunlap, the son of the donor. The building was completed in a year. The excavation for the mighty cement pier for the great telescope was begun in March 1933 and this work was completed in three months. The order for the steel dome was given in November 1931 and it arrived at the water-front in Toronto on July 31, 1933. It was erected within six weeks. The telescope

mounting arrived in Toronto on October 15, 1933, and within two weeks was mounted on its pier.

There was some delay with the immense disc of glass for the main mirror of the telescope, but on June 21, 1933, a happy and interested party from Toronto saw the 2½ ton disc poured from a superior type of "pyrex" glass at the Corning Glass Works, Corning, N.Y. After remaining in the annealing kiln for three months it was examined, declared good and then shipped to England to be ground and polished. Within its 5-ton shipping case, on the second day of this very month, it was moved into the great dome through an opening made in the wall, and five days later the mirror was safely placed in its cell and then attached to the telescope. The telescope is now completed.

Before resuming my seat I wish to make some acknowledgements.

Upon the name of Mrs. Jessie Donalda Dunlap we need not dwell. Were it not for her outstanding benefaction there would be no observatory here. To her all the credit is due.

Then I must mention the name of a person who, I know, would strongly demur if I told him I intended to do so. I refer to Mr. John B. Holden, the former business associate and friend of Mr. Dunlap and the legal adviser and friend of Mrs. Dunlap. Mr. Holden is a faithful guardian of her interests, but he appreciated at once the fine quality of the memorial and has heartily co-operated in making the observatory worthy of its object.

Of the work of the architects, Messrs. Mathers and Haldenby, I need only say that their creation is acclaimed by everyone as beautiful, appropriate and effective. The contractors also, Messrs. Sullivan and Frid, the Ramsay Contracting Co., Jordan-Roberts of Brantford, the Dominion Bridge Co., as well as the numerous staff of the Superintendent of Buildings of the University, all deserve commendation. One must specially mention the English firm, Sir Howard Grubb, Parsons and Co., which supplied the great telescope and the steel dome. It is a miracle of mechanism, and our relations with the firm have been very cordial. It is much to be regretted that Sir Charles Parsons, the distinguished head of the firm, did not live to see the telescope completed. He had a lively interest in it. I have been intimately associated with the great project in all its details, and everyone employed on it seemed to me to realize that it was a very special undertaking which demanded his best efforts.

I wish also to refer to the assistance rendered by the Royal Astronomical Society of Canada, the Council of which has loaned us the valuable technical portion of its library. We hope the Society will find it even more accessible here.

I may remark that the first three volumes entered in the accession book of our library bear the autograph of D. A. Dunlap.

Finally let me refer to the ability and enthusiasm of my colleague, Professor R. K. Young. No mathematical problem which we encountered was too hard for him to solve, no mechanical intricacies were too difficult for him to master and no labour was too long for him to undertake and carry to a conclusion.

Friends have remarked to me that I have spent a long time in my endeavour to secure this observatory. True it is that thirty years is a considerable time, but it is as nothing compared to the decades and centuries during which a stream of astronomical research will proceed from this noble memorial, bringing honour to the name it bears and to its donor, and also conferring distinction on our land.

The chairman then asked for a few words from the one who was directly responsible for the construction of the great telescope.

MR. CYRIL YOUNG, *General Manager of Sir Howard Grubb, Parsons & Co., Newcastle-on-Tyne, England.*

When I paid my first visit to the Observatory last Tuesday I could not help feeling proud that the firm of Sir Howard Grubb, Parsons & Co, with whom I am associated and whom I have been very kindly invited to represent today, should have had the honour of building the 74-inch Reflector, the principal instrument in this observatory, so kindly provided by Mrs. Dunlap's munificence.

In designing and constructing the Telescope and Dome, we have had to collaborate with Dr. Chant and Dr. Young, and I am glad to say that our relations throughout have been most happy. We have been very fortunate in having on the spot Mr. F. Jno. Bell, who so ably looks after Messrs. Parsons' interests in Canada. I wish to take this opportunity of acknowledging the assistance given by my chief, Mr. Bedford, who is here today. He has given us every facility to obtain the help of any of the experts at the Heaton Works who could in any way contribute to the successful manufacture of the Telescope. This assistance has been most generously given and I am sure they would feel proud if they could see today the results of their contribution.

I must specially mention the name of Mr. Armstrong who was responsible for working the 74-inch mirror. When I explain that every portion of the surface of an astronomical mirror should be worked true to its theoretical contour to within 2-one-millionths of an inch you will understand that the task of making a successful mirror is a very arduous one.

Some weeks ago Dr. Young paid a special visit to Newcastle-on-Tyne in order to test Mr. Armstrong's work, and from the results of these tests we have every reason to believe the mirror to be a very good one.

I cannot conclude without a reference to the enterprise of The Corning Glass Works, which manufactured the "pyrex" disc for the mirror. This was the largest disc they had made up to that time, although since then they have produced several larger, including one of 200 inches diameter. The greatest credit is due to Dr. O. A. Gage and his colleagues at Corning.

My only regret is that Sir Charles Parsons did not live to be here today.

The next speaker was introduced by the chairman as a distinguished representative of British astronomy.

SIR FRANK DYSON, *K.B.E., Astronomer Royal* 1910-1933

In the first place I should like to congratulate the University of Toronto on the beautiful observatory and magnificent telescope given to them by the generosity of Mrs. Dunlap. Then I think Mrs. Dunlap should be congratulated on the worthy memorial she has made to her husband Mr. David Dunlap. As the Latin poet says, "it is a memorial more lasting than brass," and Mr. Dunlap, who was keenly interested in astronomy, would have desired no better tribute. Lastly, Professor Chant is to be congratulated on the consummation of his hopes on this day, his 70th birthday. Prof. Chant has been a great power in furthering the study of astronomy in Canada. Besides the number of students he has taught he took a large share in establishing the Toronto Astronomical Society which in after years became the Royal Astronomical Society of Canada and has spread right across the Dominion.

I have had the opportunity of seeing the telescope. Its general appearance is most workmanlike. I was very glad the contract was given to the firm of Sir Howard Grubb, Parsons and Co. Sir Charles Parsons was the famous engineer who by the invention of the steam turbine comes next to James Watt in getting power out of steam. Sir Charles was the son of Lord Rosse, who made the biggest reflecting telescope of the nineteenth century, and was interested in the manufacture of optical glass. Later he associated himself with the famous firm of Sir Howard Grubb, which had made many large telescopes, and thus acquired the experience of Mr. Cyril Young, who became the manager of the telescope works at Newcastle, and of Mr. Armstrong who was a real artist in the figuring of mirrors and lenses. I am quite sure the 74-inch mirror is a very perfect instrument. Both the mirror and the spectroscope, which was constructed by the firm of Adam Hilger, have passed the severe scrutiny of Prof. R. K. Young. Then I cannot imagine a more beautiful site for an observatory than Richmond Hill. It is far enough from Toronto to escape smoke and glare and sufficiently near for the teaching purposes of the University.

But a telescope is not much good without suitable astronomers to work it. I should like to congratulate Prof. Chant on his staff. I have only recently met Dr. Young but know of his work at Lick and Victoria. But I had the pleasure of meeting Prof. Hogg at Victoria. Prof. Plaskett with whom I was staying took me to the 72-inch. Naturally Prof. Hogg was there. I was not surprised to see Mrs. Hogg, because I knew she was a Harvard graduate and was working on Cepheid variables in the cluster Messier 2. But I was surprised to see a baby a few weeks old sleeping in the dome. That shows the enthusiasm of her parent. With enthusiasm and skill great things will be accomplished, and I look forward with every confidence to the future of the David Dunlap Observatory.

President Cody then requested Professor Curtis, of the comparatively near University of Michigan, to address the gathering.

DR. HEBER D. CURTIS, *Director of the Observatories of the University of Michigan*

It is a great pleasure and honour that is mine today in bringing to the University of Toronto the congratulations and good wishes of the University of Michigan, a sister institution of learning lying on the other side of that imaginary line that divides two peoples who are so essentially the same in every respect.

In all our great universities there are groups of men who attempt to find out things about this universe and to translate and pass this knowledge on to the rest of the world. The geologist teaches us the lore of things beneath the crust so that we may mine our coal and iron; the botanist learns to know the life and needs of plants and makes this knowledge help us with our crops; the engineer builds our bridges and teaches us how to make steel, steam and electricity our slaves; the historian or economist shows us the errors of the past and how we may avoid them in the present. But I should not personally care to be the historian; we are apt to believe implicitly the lessons that the geologist, the botanist, or the engineer teaches us, but we humans seem to go right on making the same old mistakes in so far as the lessons of history are concerned.

The astronomer, by and large, renders no such utilitarian service to mankind and, on the whole, I am rather glad that this is so. He gives us rather something that enlarges our souls in a knowledge of the universe without; the inflexible and beautiful laws of the greater spaces; he brings to us aggregates that are so inconceivable in mass, or distance, or in the time factor that we can not go far wrong in applying to this external universe the tremendous adjective, —infinite. And it is a wonderful thing that our souls may thus come in contact with the infinite, for we do not live by bread alone.

It is unnecessary to repeat here the details of telescopic equipment and power that make the David Dunlap Observatory so notable an adjunct to the scientific work of the University. We of the world of science prophesy for the new observatory a long and useful life. In this fine plant there will be carried on in all the decades to come researches of value on the world of the stars without—their elements, constitution, and motions. Many of the studies thus made will doubtless seem too highly technical and abstruse for the man in the street, yet all will have their individual parts in that greater picture of the universe that the astronomer is trying to paint for the world.

It is thus an unusual pleasure for me to join with this audience in congratulations to the University of Toronto at the dedication of this fine plant and new tool of research; our felicitations as well to Dr. Chant on this his natal day that marks also the successful fruition of his decades-long dreams made possible for the University an acquisition so notable as the David Dunlap Observatory.

The next speaker was the representative of the great Harvard University at Cambridge, Mass.

PROFESSOR HARLOW SHAPLEY, *Director of the Harvard Observatory*

Dr. Shapley congratulated Canada on the opening of such a magnificent observatory. As judged by the quantity and quality of equipment, Canada was now the outstanding country in the astronomical world. The only other place of comparable size in which there was similar interest was South Africa, and there the interest was not native, but rather due to outsiders who had set up observatories in that country owing to its situation in the southern hemisphere and to its very fine astronomical climate. He particularly stressed that in an observatory such as this, the balance should be maintained between popular interest in astronomy and freedom of the staff to pursue the researches that such generous equipment warranted. He welcomed the observatory as a further important element in the making of western hemisphere astronomical research a thing for the future generations to think about. Dr. Shapley complimented Mrs. Dunlap on the magnificence and suitability of her contribution to science. He also congratulated Dr. Chant on his birthday, and especially on the "pretty trifle" he had received as a birthday present. He feared Dr. Chant's tastes might become so extravagant that in the future, suitable birthday gifts might be really difficult to supply.

Dr. Shapley also spoke of his personal interest in Toronto as an astronomical centre in that three of the astronomers here, Frank S. Hogg, Helen Sawyer Hogg, and Peter M. Millman, had been "doctored" by him at Harvard University. He thus felt he had a greater interest and responsibility here than at any other observatory but his own, and suggested that this mutual interest be a basis of constructive co-operation.

The last speaker of the afternoon was introduced as a graduate of the University of Toronto, who had achieved distinction in the astronomical world by his work at the observatories at Ottawa and Victoria.

W. E. HARPER, M.A., *Acting Director of the Dominion Astrophysical Observatory, Victoria, B.C.*

It is certainly a great privilege and honour to be invited to participate in the formal ceremonies connected with the dedication of this great observatory. There is, moreover, a peculiar pleasure that comes to myself, and I am sure to all who know Dr. Chant well, in the thought that the dream of his life has at last been fulfilled. The establishment of this observatory with its marvellous telescope for studying the secrets of the heavens is a fitting climax to his professorial career in the University.

As Editor also of the *Journal* of the R.A.S.C. since its inception over thirty years ago he has devoted himself unselfishly to building up astronomical centres across Canada where leadership is given to the study of this, the oldest of the sciences. It is not at all surprising, then, that in addition to the formal greeting which has just been read from the General Executive of the Society there should come from these various centres across Canada congratulations and good wishes to Dr. Chant and to the University which receives this splendid gift.

I understand that Dr. Chant, who seems to remain ever young, will now be free to devote his whole time to astronomical research. He will have associated with him several who have been co-workers with myself at Victoria. It might, therefore, be thought that we would cherish some animosity towards him and the University for enticing away some of our best workers in the persons of Dr. Young, Dr. Millman, Dr. Hogg and his talented wife. Such is not the case, for while we regret losing them we recognize that they have greater opportunities here. Moreover, in the early days, before we could secure our own, Dr. Chant was kind enough to loan us much needed equipment and he has ever been a good friend of the Victoria observatory. Surely, then, we can in some measure attempt to repay his kindness by allowing him and the University to have some of our best workers.

This telescope, as has just been mentioned, has a diameter two inches greater than ours at Victoria and now ranks as the second largest in operation. By reason of thus taking precedence in size over our own, it might be suspected that we would be envious. Again, such is not the case. Like a loyal suspected that we would be envious. Again, such is not the case. Like a loyal British Columbian, I shall only say that with the wonderful climate we enjoy and the consequent high quality of our seeing, we feel we can afford to accept a handicap of a mere couple of inches. That is a mere trifle, you know.

There is a well-worn saying that one may judge of the degree of the civilization of any nation by the provision which that nation makes for the study of astronomy. Now that you good people of the east have a really worthwhile observatory we westerners will believe there is hope for the east yet! Seriously though, speaking for the Dominion Astrophysical Observatory, we welcome this new observatory into the field of astronomical endeavour.

We expect great contributions from this observatory and I am sure we shall not be disappointed. It is a great thing to be able to make possible such achievements and greater still to be the one willing to do so.

Mrs. Dunlap may well be assured that for generations to come people will point with pride to this establishment as a worthy example of how to perpetuate the memory of a loved one. We may well use scriptural language and say that it will be as a city that is set upon a hill which cannot be hid or as a lamp which giveth light to all the world.

May her example serve to stimulate others to apply their wealth to similar memorials seeking to discover Truth, for "The truth shall make you free."

II.

SPECIAL CONVOCATION OF THE UNIVERSITY

THE second impressive ceremony of the day took place in the evening when the University of Toronto called a special convocation to confer honorary degrees on six persons who had made notable contributions to astronomy. The degree of Doctor of Laws was conferred on Mrs. Dunlap, Sir Frank Dyson, and Prof. Chant; and the degree of Doctor of Science on Dr. Harlow Shapley, Dr. V. M. Slipher, and Mr. W. E. Harper. The Chancellor of the University, Sir William Mulock, was unable to be present because of illness, and President Cody occupied his chair. Present on the platform, besides university officials, the recipients of degrees, and those who read the citations, there were His Honour the Lieutenant-Governor, Dr. Bruce; the Hon. L. J. Simpson, M.D., Minister of Education, and his Deputy Minister, Dr. Duncan MacArthur; the Hon. J. A. Faulkner, M.D., Minister of Health; His Worship the Mayor of Toronto, Mr. James Simpson; Sir Joseph Flavelle, and Mr. W. L. Mackenzie King.

The candidates for degrees who would ordinarily have been presented to the Chancellor by President Cody were presented by various prominent members of the faculty who read the president's citations. After each candidate had been given the degree, he inscribed his name in the Golden Book of the University, which contains the names of all the recipients of honorary degrees. The ceremonies were enhanced by the fact that the leader of the opposition in the House of Commons of Canada, Mr. Mackenzie King, was present and spoke brilliantly though briefly.

During the course of the evening, President Cody spoke with regret of the retirement of Professor Chant as head of the Department of Astronomy and Director of the Observatory, but stated that he would remain on the staff in an honorary capacity. Dr. Cody announced the appointment of Dr. Reynold K. Young as the new Director of the Observatory.

Preliminary to the conferring of degrees the President remarked that this was a red-letter day in the history of the University of Toronto. "It marks," said he, "a decisive advance in our scientific equipment. Today has been formally opened the David Dunlap Observatory, a magnificent gift to the University made by Mrs. Dunlap in memory of her honoured husband, that his name may be perpetuated in connection with the high realm of astronomical research, and that this University may share with other observatories throughout the world the task of investigating the field of stellar velocities and spectral photometry and in similar co-operative labours."

He then called on Professor E. F. Burton, head of the Department of Physics in the University, to present Sir Frank Dyson for the degree of LL.D. Professor Burton read the following citation:

Mr. Chancellor, I present to you one who has just retired from the historic post of Astronomer Royal and director of the Royal Observatory at Greenwich, an institution founded in 1675 by that Stuart monarch with a scientific bent, King Charles II.

Frank Watson Dyson was born in an English Baptist parsonage and has never forgotten his fundamental religious associations, as is witnessed by his acceptance in 1921 of one of the vice-presidencies of the British and Foreign Bible Society. Educated at Bradford Grammar School and Trinity College, Cambridge, he graduated with the mathematical blue ribbons of Second Wrangler and Smith's Prizeman. In 1894 he became chief assistant at the Royal Observatory, Greenwich, and in 1899 secretary of the Royal Astronomical Society. In 1905 he resigned these duties to become Astronomer Royal for Scotland. This post he held till 1910, when he was appointed Astronomer Royal at Greenwich. For twenty-three years he held this high office retiring in 1933 at the remorseless demand of the age limit.

Many honours have come to him in recognition of his astronomical researches. He was knighted in 1915 and made a K.B.E. in 1926. He was elected a member of the Royal Society in 1901. Edinburgh, Oxford and Cambridge have given him their highest academic distinctions.

From 1894 onward he has published innumerable scientific papers. Three outstanding features of his scientific achievements may be mentioned. (1) at Greenwich Sir Frank's chief work lay in the astronomy of position—the determination of the proper motions of the stars. To determine these motions there is need of a clearly defined programme, great persistence and observations of the utmost precision. This kind of work may lack the spectacular features which appeal to the many, but it constitutes the very foundation on which astronomical progress rests.

(2) Sir Frank accompanied the eclipse expeditions of 1900, 1901 and 1905 as Greenwich chief assistant, and his services in connection with these show that he would have won equal eminence in astrophysics had he devoted himself to that branch of astronomy.

(3) When Einstein in 1915 published his paper on the relativity theory it was at once recognized that the new theory had an important bearing on astronomy. Einstein himself had suggested that the tests of its correctness were astronomical in nature and that one of them could be applied to observations made at a total eclipse. Two English expeditions were planned even when the Great War was raging—to observe a total eclipse in May, 1919. One went from Cambridge to Africa under Sir Arthur Eddington, the other from Greenwich to Brazil under Sir Frank Dyson. Both were successful and obtained evidence in support of Einstein's theory. These brilliant observations brought great fame to English astronomy and in making them Sir Frank Dyson took a leading part.

We honour our University in adding to our company this great man of singular modesty and singular achievement.

I, therefore, present to you, Mr. Chancellor, Sir Frank Watson Dyson, K.B.E., F.R.S., LL.D., D.Sc., former Astronomer Royal, to receive at your hands the degree of Doctor of Laws, *honoris causa*.

Hon. N. W. Rowell, K.C., presented Mrs. Dunlap for the degree of LL.D. in the following words:

This University has been glad to invest with its highest academic honours certain notable women whose services to others have richly deserved public recognition. Tonight we add another to this selected group—the gracious lady who, wisely affection and wise benefaction have made possible the erection of this great observatory, Mrs. Jessie Donalda Dunlap.

From those to whom much is given, much by divine law is required. Mrs. Dunlap has sought faithfully and with discrimination to discharge her duties of stewardship in the use of her possessions. It is not for me this evening to mention the manifold causes she has generously helped. I speak only of some of the educational institutions which have been able to advance because of the munificent aid which her husband and she herself have given to them. St. Andrew's College, the Toronto General Hospital, the Medical and Psychological departments of this University.

The climax of her helpfulness to the University of Toronto has come in the provision of the observatory and its site as a memorial to her late husband, David Alexander Dunlap. She shared her husband's interest in astronomy, that science which at once humbles and exalts the mind and soul of man, and responded with considered, yet prompt generosity to the suggestion that

she should do this great thing for the furtherance of astronomical research in Canada. Today she has handed to the University a superb addition to its scientific equipment, in the confident hope that through these new facilities the confines of astronomical knowledge may be ever enlarged, the mysteries of the universe may become more intelligible, and the starry heavens above may, as Immanuel Kant said, in conjunction with the moral law within, continue to bear witness to Him "who is before all things and in whom all things consist".

The University of Toronto wishes to mark its appreciation of Mrs. Dunlap's public philanthropies to this community and its profound gratefulness for her many benefactions to this institution by conferring upon her the highest academic distinction within its power.

I, therefore, present to you Mrs. Jessie Donalda Dunlap that she may receive at your hands the degree of Doctor of Laws, *honoris causa*.

Professor Lachlan Gilchrist, President of the Royal Astronomical Society of Canada, then presented Professor C. A. Chant for the degree of LL.D., in the following statement prepared by President Cody:

It is not the happy lot of many to see their dreams come true and attain the goal of their life's effort. To Professor Chant this rare experience has come. Today, his seventieth birthday, is the crowning day of his long career. It is our privilege to rejoice with him in his rejoicing.

He graduated from this University in 1890. It was my good fortune to be a fellow-student, graduating one year earlier. We were both officers in that famous and still persisting organization—the University College Literary and Scientific (now Athletic) Society. Another member of our committee was George Howard Ferguson. A year after his graduation, Dr. Chant was appointed Fellow and next year Lecturer in Physics. When the new department of astrophysics was established in 1907 he was made associate professor, and became full professor in 1918. This post he has held till the end of this academic year, when he retires under the age limit. I am glad to say that the Board of Governors has appointed him Professor Emeritus of astrophysics and Emeritus Director of the Observatory, as well as its Honorary Librarian and director of publications.

His whole life has been devoted to the teaching of astronomy and to emphasizing its value as a cultural subject in a liberal education and as a fine discipline for the advanced student. From the beginning of his work he has urged that the University should have an observatory, and so make some fresh contribution to our knowledge of astronomy. In this programme for astronomical advance in Canada, great interest was taken by Mr. David A. Dunlap, an enthusiastic amateur in the field of astronomy and a member of the Royal Astronomical Society of Canada, one who believed that (in Kepler's phrase) astronomers were thinking God's thoughts after Him. Some time after his death in 1924, when Professor Chant suggested to Mrs. Dunlap that she provide an observatory as a fitting memorial of her husband, she gave a sympathetic and munificent response—and the issue has been the great observatory and telescope dedicated to day to the cause of astronomical research.

There are other phases of Professor Chant's work that deserve to be mentioned. (*a*) He was one of the earliest experimenters in wireless. While he was an undergraduate, Hertz in Germany discovered the method of producing electric waves and thus opened the way for the future development of wireless telegraphy and radio. In 1895 when Mr. Chant was a lecturer in physics he constructed the necessary apparatus and first demonstrated to a Toronto audience the properties of these waves. In 1899 before the Canadian Institute he showed, perhaps for the first time in Canada, how to send and record a wireless message.

(*b*) He has played an important part in the development of the Royal Astronomical Society of Canada. He joined the original society in 1892, and from 1904-7 was its president. In 1905 he edited its transactions. In 1907 he began the publication of the *Journal* of the Society, which is now in its 29th volume and is sent to all parts of the world. At his suggestion local centres of the Society have been organized in various parts of Canada.

(*c*) He has written admirable and widely-used text books. In collaboration with Dr. F. W. Merchant he prepared the *High School Physics*. The first edition appeared in 1911 and a revised edition in 1923. All the Canadian provinces have used it as a text book and it has had a wide circulation in the United States. More than 275,000 copies have been issued. The same authors have published three other school text books which have had a combined circulation of 140,000.

In 1928 he wrote a small book on astronomy called "Our Wonderful Universe." This has been published in England, Canada and the United States, and has been translated into German, Czech and Polish.

In 1933, in collaboration with Professor E. F. Burton, head of our department of physics, he published a text book of college physics, and this is being used in many colleges in Canada and in the United States.

(*d*) He has made five expeditions to observe total eclipses of the sun. In the 1922 expedition to Western Australia evidence was secured in verification of Einstein's theory.

Surely at the close of his long academic career in this University and on the day of the opening of the Dunlap Observatory—his realized dream—we do well to honour our own Professor Chant, a scientist "indeed in whom is no guile."

I present to you, Sir, Clarence Augustus Chant, M.A., Ph.D., Fellow of the Royal Society of Canada, Professor of Astrophysics in this University, that he may receive at your hands the degree of Doctor of Laws, *honoris causa*.

Professor Harlow Shapley was presented for the degree of D.Sc. by Professor J. L. Synge in the following words:

Equipment for astronomical research has nowhere been brought to a higher degree of efficiency than in the neighbouring Republic. Some of the finest observatories of the world are there situated. Mt. Wilson Observatory has at the moment the largest telescope in existence, and the glass is still cooling for the marvellous 200-inch mirror which the Mt. Wilson organization will some day add to its instruments for observing the heavens.

One of the most famous astronomers in the United States I now present to you in the person of Dr. Harlow Shapley. From the University of Missouri from which he graduated, he went to Princeton as a Fellow. From 1914 to 1921 he was a member of the staff of the Mt. Wilson Observatory. From this he came to Harvard in 1921 to be Director of the Observatory and Paine Professor of Astronomy, and has proved himself a worthy successor to the late Edward C. Pickering. His researches have been in the fields of photometry, spectroscopy, and cosmogony.

While he was at Princeton he made notable contributions to the theory of variable stars, especially those known as eclipsing variables. This work he greatly extended at Mt. Wilson, and was able to utilize it in determining hitherto unmeasured distant portions of the universe. This led on to investigations into the nature and distance of star clusters, and their relation to our system of stars. He gained new views of the structure and dimensions of our milky way or galactic system, and revealed that our universe was infinitely greater than we had previously believed it to be. What a being is man, able to understand and formulate theories about this vast yet intelligible universe!

Professor Shapley is a member of many scientific societies, including the National Academy of the United States, the American Astronomical Society, the Royal Astronomical Society of Canada, and the Royal Astronomical Society of London.

He was Lowell Lecturer at Boston in 1922, Exchange Lecturer in the Belgian Universities in 1926, Halley Lecturer at Oxford in 1928, and George Darwin Lecturer in 1934. He has been awarded the Draper Medal of the National Academy in 1926; the Universities Medal, Brussels, 1926, the medal of the Society of Arts and Sciences 1931; and the gold medal of the Royal Astronomical Society of England in 1934.

Among his early publications were papers on astronomy in Horace and in Lucretius. From Lucretius may be quoted (in translation) lines which fairly describe our distinguished visitor: "Therefore the living force of his soul gained the day; on he passed far beyond the flowing walls of the world, and traversed throughout in mind and spirit, the immeasurable universe; whence he returns a conqueror, to tell us what can, what cannot, come into being."

We are grateful for his presence with us to-day.

I present to you, Mr. Chancellor, Harlow Shapley, one of the world's great astronomers, to receive from you the degree of Doctor of Science, *honoris causa*.

Professor Reynold K. Young then presented Director V. M. Slipher, of the Lowell Observatory, Flagstaff, Arizona, for the degree of D.Sc.:

For centuries the fiery planet Mars has been an object of interest to astronomers and laymen alike, and as telescopes became larger in size and better in quality strange details were detected on the surface of the planet. In 1877, the Italian astronomer, Schiaparelli, reported that he had seen faint straight markings on the planet, and after some years of observation he drew a map of the surface of Mars on which was a network of lines. These were so straight and regular that he called them *canali* (channels), but the world called them canals. Percival Lowell, member of a well-known Boston family and a distinguished graduate of Harvard, was greatly attracted by these observations and determined to devote himself and his means to investigations on Mars and the other planets. After a search for the best site he established the Lowell Observatory at Flagstaff, Arizona, at an altitude of 7250 feet above the sea, and gathered about him a number of able and enthusiastic young men.

One of these was Vesto Melvin Slipher, a native of the Hoosier State, Indiana, and a graduate of its State University. He joined the staff of the Lowell Observatory in the year of his graduation, 1901; he became assistant director in 1915, and director in 1926.

Mr. Slipher's special field of research is spectroscopy, and his investigations on the planets, not merely on Mars, have been of outstanding value. With skill, ingenuity and abounding patience, he has secured much information regarding the atmosphere, the surface conditions and the rotation of the planets. One of the latest results deduced from his spectrum photographs is that there is much of the poisonous gases, ammonia and methane (or marsh gas) in the atmosphere of the outer planets of our solar system.

But he has not confined his attention to our family of planets. Indeed he has attacked some of the most difficult problems of the great universe of stars beyond. From his early spectra of the stars he found evidence of the presence, throughout space, of clouds of calcium vapour, a discovery now recognized as of great importance.

His spectrum photographs were among the first to lead to the belief that the diffuse nebulae owe their illumination to the bright stars in their neighbourhood. By the inclination of the lines in the spectra of some spiral nebulae he was able to demonstrate that such nebulae are moving outward on the arms of the spiral.

In recent years we have been told that our universe is expanding, that every part is moving away from every other part. This result is deduced from Einstein's theory of relativity. One reason for the general acceptance of this view is, that, before the general theory of relativity was announced, Mr. Slipher had actually obtained photographs which showed that some of the spiral nebulae were moving in space with speeds of several hundred miles a second.

In most of his researches his work has been that of pioneer, and has proven to be of fundamental importance in formulating our theories of cosmogony.

He has been honoured by election to many scientific societies, by receiving honorary degrees, and by the award of the Lalande Prize and Gold Medal from the Paris Academy in 1919, and the Gold Medal of the Royal Astronomical Society in the year before Dr. Shapley received it, 1933. He has also been the George Darwin Lecturer in 1933.

I, therefore, present to you, Mr. Chancellor, Vesto Melvin Slipher, Ph.D., LL.D., Sc.D., director of the Lowell Observatory and a great interpreter of the starry universe, that he may receive at your hands the degree of Doctor of Science, *honoris causa*.

Professor Samuel Beatty, head of the Department of Mathematics in the University, presented Mr. W. E. Harper, of Victoria, B.C., for the degree of D.Sc., in the following words:

Canadians have taken their part in recent years in the work of astronomical research. In a new country like ours, it has not been unnatural that emphasis in the field of science should be placed on subjects that seemed to be of immediate utility. Yet pure science has made great strides on its own account, and among pure sciences astronomy has gained increased prestige and aroused fresh interest by reason of recent spectacular discoveries which have vastly enriched our knowledge of the universe. The life work of Professor Chant has not been in vain, and astronomy has come into its own. Two of our graduates, Dr. J. S. Plaskett, formerly director of the Dominion Astrophysical Observatory at Victoria, B.C., and his son, Professor Harry Plaskett, now Savilian Professor of Astronomy in the University of Oxford, have made great contributions to this fascinating and overawing science.

To-night I present to you another of our graduates whose astronomical work has been of signal value. He is in a sense Dr. Chant's "son in the astrophysical faith." Professor and pupil stand side by side in this Hall to-night to receive the highest honour their Alma Mater can bestow upon them.

William Edmund Harper came from that Ontario County of Bruce. From the Owen Sound Collegiate Institute he came to this University in 1902 and took the course in Mathematics and Physics. At Professor Chant's request, the Senate of the University in 1905 instituted a new division in this department, known as Astronomy and Physics. It was established in time for the graduating class of 1906, and Mr. Harper was the first graduate in this section. In order to encourage the study of astronomy, the Royal Astronomical Society of Canada had offered a gold medal to the candidate obtaining highest standing in the new course. The first award was made to Mr. Harper. The day of his graduation he received notice that he had been appointed to the staff of the recently founded Dominion Observatory at Ottawa. There he remained until 1919 when he was transferred to the new observatory at Victoria, B.C.

For the last twenty-nine years Mr. Harper has laboured effectively in the field of astronomical research, especially in astrophysics. With great skill and patience he has taken and measured thousands of photographs of the spectra of the stars, and from them the velocities of the stars and other wonderful results have been determined. He has discovered a large number of binary stars, which are pairs of suns far out in the depths of space revolving about each other. He has, it is said, computed more orbits of such systems than has any other human.

In co-operation with Dr. R. K. Young, of our own department of astrophysics, Mr. Harper determined, from their spectra, the absolute brightness, and hence the distance, of over 1100 stars, a great and important achievement. Only on such observations can an intelligent view of the universe be based.

Mr. Harper is a Fellow of the Royal Society of Canada and a past president of the Royal Astronomical Society of Canada. He has done much to popularize astronomy by his articles in newspapers and magazines, and by lectures and radio addresses. He is now the Acting-Director of the Astrophysical Observatory at Victoria—over which Dr. J. S. Plaskett presided for many years.

The work of this alumnus of our University has brought distinction to himself, to his native land and to his Alma Mater, who now greets and honours her academic son.

I present to you, William Edmund Harper, that he may receive from you the degree of Doctor of Science, *honoris causa*.

Addresses by the Recipients of Degrees

The chairman then invited the recipients of degrees to address Convocation, and the first to respond was Sir Frank Dyson, who spoke as follows:

I am commissioned by Mrs. Dunlap to say how highly she appreciates the great honour you have conferred upon her by giving her the degree of Doctor of Laws. She wishes me to express her thanks for the many kind things which have been said of her and to her. For myself, I am very proud to be a Doctor of Laws of your famous University. I know that two of your graduates have been Prime Ministers of the Dominion of Canada. But I have a peculiar gratitude to the University of Toronto. The Medical Faculty, Banting, McLeod, Collop and Best, by the discovery of insulin, prolonged my sister's life for many years. As regards astronomy, nearly all the Canadian

astronomers, Chant, Meldrum Stewart, Young, Hogg, Millman and the Plasketts—father and son—were graduates of the University of Toronto, and many of them Prof. Chant's pupils. Now you have this magnificent observatory and the best I can wish for you is that it may become as famous as the Greenwich Observatory, which has been of service to astronomy for 260 years. As one who has been many years at Greenwich I am glad to come as a representative of the English astronomers but am very sorry my distinguished colleagues, Eddington and Jeans, found it impossible to leave England. The honour you have conferred on me is all the greater because it is associated with Mrs. Dunlap and the distinguished representatives of astronomy from Canada and the United States.

The chairman then called on Dr. C. A. Chant, who said:

My first wish is to thank the Senate for conferring on me the high degree of Doctor of Laws, here, in the presence of so many of my friends and in such distinguished company.

As has been intimated by the President, I have come to the close of a long period as an instructor in the University, and perhaps I may be allowed to offer a few reminiscences.

This thirty-first of May has been a wonderful day in my life. I suppose it might well be marked by a red letter or a golden number, as of old, and yet nothing of that sort is needed to remind me of it or for my complete satisfaction.

In 1891, a year after graduation, I returned to the University as Fellow in the Department of Physics, at $500 for the session. One year later I received a permanent appointment as lecturer at $800. During the operation of moving to our new and lovely home up at the Observatory I came across the letter from the Assistant Provincial Secretary informing me of that appointment; also a similar letter one year later stating that the salary had been increased to $900. At the present time that salary looks small, and I suppose it was, but I had no complaints whatever to make. I was glad of the opportunity to get back to my Alma Mater.

Thus began my association with the young men and women from the high schools of Ontario who year after year came up to the University. Surely they are the finest in the whole world! To assist in moulding their minds and characters has been my great privilege. A teacher can have no greater joy than to see his students win high place in the world; and there have been so many classes which have gone forth in the last forty-four years that everywhere I am greeted by my former students.

Then also I entered on a life-time of the study of science and, as Charles Kingsley has remarked, "Science, like virtue, is its own reward." While that is true of all sciences, I think it is especially so of astronomy.

I think my mind was first turned in that direction when I was at the high school, by reading a school book entitled "Geography Generalized," by Robert Sullivan, of Dublin, Ireland. I have the book still. It has my eldest brother's name in it, with the date 1870, although this is a copy of the 27th edition which was issued in 1861. It contains a well-arranged and very readable introduction to astronomy. I note in the book some statements indicative of the epoch. The author continues to give the name Herschel to the planet next beyond Saturn which even then was known on the continent as Uranus. He also gives the distance of the earth from the sun as 95 million miles, instead of 93, and the velocity of light at 192,000 miles per second instead of 186,000.

Soon after being appointed to the University staff I joined the Astronomical and Physical Society of Toronto, which in 1903 became the Royal Astronomical Society of Canada. There I met a number of practical observing astronomers, who further stimulated my interest in astronomy. I was president of the Society for four years and formed some valued friendships with the members. I venture to hope that I have been of service to the Society.

In this way I was led to realize the slight attention paid to astronomy in the University and the lack of means for practical instruction, and I looked about for some way to improve matters. I suggested to my colleagues in Mathematics and Physics that I be given the instruction in Astronomy and they readily agreed. This was nearly thirty years ago, and it is interesting to look back on the growth of the department of astronomy. As the years went by my hopes for equipment for the University broadened, but I had not dared to expect anything so fine as that which, thanks to the great generosity of Mrs. Dunlap, we now possess. The completion of the David Dunlap Observatory has exceeded my rosiest dream. In the coming years, yes, in not many years, I predict with the greatest confidence, its staff will place it in a foremost position in the world of astronomy.

I conclude with one more word. Nothing has pleased me quite so much as the very generous words of appreciation of my colleagues in the University, those among whom I have lived ten, twenty, in some cases, over forty years.

The next speaker to address the gathering was Dr. Harlow Shapley.

Dr. Shapley, in thanking the University for this honour and paying further tribute to Mrs. Dunlap, stressed that the completion of the observatory was only the starting of its life and work. If it were to fulfil the purpose of its foundation, it must with care and diligence select and pursue active and fruitful research programmes. He spoke briefly of some of the difficulties and limitations encountered in attempts to solve the various problems of the universe, and jokingly condemned the universe for being so uncooperative with research workers. He referred particularly to such difficulties as the blocking up of regions of the Milky Way with absorbing matter and suggested that Omnipotence should clean up the milky way of cosmic debris.

Yet, given the universe in its present uncooperative form, it was all the more urgent that we devise means of learning its structure in spite of difficulties. He suggested four chief fields in which he thought the equipment of the observatory and experience of its staff might produce profitable results. These comprised the determination of spectroscopic binary orbits, both for statistical analysis of characteristics of the stars, and for detailed studies of some of the more accessible members of this group; the quantitative analysis, from the astrophysical point of view, of stellar spectra; the study of star clusters and the study of the cosmic debris, as found in meteors, asteroids, and general absorbing matter in space.

The chairman then asked Dr. V. M. Slipher to speak, which he did in the following words:

I wish to express my sincere thanks to you and to the University of Toronto for honouring me with this degree. This is indeed the greater honour because it is given by an internationally great University.

I deeply appreciate such approval of my scientific work. If I have in some measure deserved this recognition it is largely because of the favourable conditions under which I have been able to study the heavens at Flagstaff. The Lowell Observatory where it has been my good fortune to do my astronomical work is well equipped instrumentally and is favourably situated atmospherically. It is located in the dry climate of the southwestern United States, is 7250 feet above sea level and has on the nearby mountains an auxiliary station at 11,500 feet altitude.

Thus surrounded, and possessed of some predilections to adventure, it has not been difficult for me to undertake new and apparently very unpromising problems, even if they required extreme effort in observing. Hence, in consequence of these opportunities, of good health, and good friends, I am here this evening and I appreciate and thank you for this honour.

May I take advantage of this opportuity to speak a few words concerning another matter which is of very great moment. Reference of course is had to the formal opening this afternoon of the excellent new David Dunlap Observatory. This magnificent observatory, given to the University by Mrs. Dunlap, is sure to be of important service to astronomy and to add still further to the high repute of your University.

On such an occasion some persons not familiar with the developments of astronomy might ask why is another great telescope needed—is not the field covered already? But with astronomy, as with medicine and many other sciences, the more we learn the more questions arise to be answered, and often times these new ones are at least as important as were the original ones. But perhaps we ought to be more specific in answering this question. And in

PLATE III.

THE GREAT DOME

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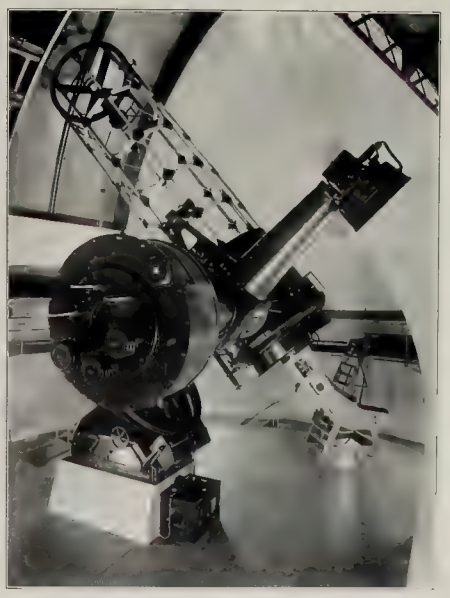
PLATE IV

THE ADMINISTRATION BUILDING, DAVID DUNLAP OBSERVATORY

PLATE X



THE 74-INCH REFLECTING TELESCOPE

PLATE XI

THE LIBRARY OF THE DAVID DUNLAP OBSERVATORY

doing so I cannot do better than to draw examples from my experience at the Lowell Observatory. Founded in 1894 by Dr. Percival Lowell for the study of Mars and the other planets, such study has been carried on there continuously since, employing every new means that could be applied to its researches. And whereas much advance has been made in our knowledge of Mars regarding his atmosphere, temperature, seasons, etc., there is still much to learn about this the best known of the planets.

The same story is to be told of the other planets. Thirty odd years ago when taking up the study of the spectra of the planets it was possible with commercial plates to photograph only from the violet to the orange. But now, thanks to repeated improvements in sensitizing dyes, it is possible to include three times the old range of wave-lengths. By thus being able to reach far out through the red into the heat spectrum, we have added enormously to our knowledge of planetary atmospheric absorptions. And recently we have been able to determine that the remarkable absorptive action of the atmospheres of the giant planets (which has long been a most puzzling question) is due to their containing surprisingly large amounts of methane gas. This substance, commonly called marsh-gas, is produced in our air by decaying vegetation, but that on the giant planets must have arisen not from *organic matter* but from *inorganic processes* of these planets. Here again important advance in knowledge raises many questions and it encourages us to push forward with the aid of this knowledge to further understanding of these neighbour worlds.

Then, breaking new ground, in 1906, prompted by the publication of Chamberlin and Moulton's planetesimal theory of the origin of our solar system, which assumed a primordial body of the nature of a spiral nebula, we set about to study spectrographically these remarkable nebulae. While this work did not tell us what was the primary state of the solar system we did find it could not be such a nebula but that these nebulae were *very* distant, extremely large bodies and were flying through space with most enormous speeds. And thus was supplied the first observational basis of the present day theory of the expansion of the universe.

And once again, the search for Dr. Percival Lowell's predicted Planet X which led to its finding at Flagstaff in 1930, within a few degrees of his predicted place, encouraged further searching of a very large belt of the sky for still more distant members of our planetary system.

So we see how one undertaking has led us to a greatly expanded universe and the other to a much enlarged solar system, both inviting much subsequent investigation. Yet these are only a few outstanding examples of progress in astronomy. Still others might be given, but these may suffice to make it evident that there is real need for new and well equipped observatories, that there is ever so much more to learn, and that there are many more fields to explore.

In conclusion I bring to the David Dunlap Observatory, to Mrs. Dunlap, its donor, to its director, Dr. Chant and his colleagues, the cordial greetings and good wishes of the Lowell Observatory. May your labours meet with results more fruitful of knowledge than your fondest hopes.

The last of the recipients of degrees to address the audience was Dr. W. E. Harper, who said:

I am deeply conscious of and grateful for the high honour just conferred upon me. I feel that any little thing I may have accomplished in the past does not merit such recognition; nevertheless, the honour will stimulate me to greater endeavours in the future.

I have often been asked, "How on earth did you come to take up the study of astronomy?" The answer can be given very definitely. I entered the University intending to qualify as a teacher of mathematics in High Schools and Collegiate Institutes. Early in my second year, though, I attended lectures on astronomy given on certain nights each month in the lecture room of the Chemical Building. I was attracted to the subject by reason of these interesting addresses given by Professors Chant, DeLury and other members of the local Astronomical Society. On entering my third year to continue my Mathematics and Physics course it seemed the logical thing to select the option which led to specialization in astronomy.

At that time I was not aware of a new observatory being under construction at Ottawa, so my choice was not in any way influenced by considerations of a "bread and butter" job. However, about the time I was ready to graduate they needed some one at Ottawa and, being recommended from here, I had the somewhat unique experience of being informed a few minutes after the graduation ceremony that I had been appointed to the Ottawa Observatory. That was how I entered astronomy.

The every day uses of astronomy do not obtrude themselves upon our notice, yet they are none the less important. The determination of accurate time, so necessary in our modern age, the application of our science to precise surveying and the delimitation of national boundaries, the calculation of the tides, the determination of the position of a ship at sea, or the aeroplane on a long flight, are all illustrations of where a knowledge of astronomy is essential.

But there are other uses, not necessarily of practical value, but worthy of consideration, nevertheless. In our quest for the beautiful in life we miss one of the richest sources of all if we have not an acquaintance with the stars. Emerson expresses the idea in this way: "If the stars were all to be blotted out and were to make their appearance only at long intervals, say once in a hundred years, how, as the critical time approached, the whole world would await with expectant awe, the oncoming of the gorgeous spectacle and how they would treasure for generations to come the glimpse they had been given of the City of God." Yes, the stars are a source of wonder and beauty.

Astronomy is a subject also that we should have some little acquaintance with if only to appreciate the many allusions to it in literature. Poetry of past ages has been rich in references to what was known as "the music of the spheres." The planets and other celestial bodies were each supposed to be affixed in a sort of crystalline shell or sphere and as these spheres rotated about their common centre, the earth, the soft gliding of one over the other produced a harmonious strain always referred to as the music of the spheres. Numerous such allusions abound in literature and can be appreciated only by those having some knowledge of the subject.

A knowledge of astronomy, moreover, prevents one being a prey to fear when catastrophies are predicted for the earth. In earlier days, before comets were known to be regular members of our system, one can understand the alarm the unexpected appearance of a comet would produce. They were supposed to be harbingers of some dire catastrophe to come upon the earth. Pestilence and death followed in their train, so it was thought. Such concern and anxiety should not exist in our day, and yet it does.

Again, if we knew even the rudiments of astronomy we would realize the hoax that is perpetuated in the casting of horoscopes which even in our enlightened 20th century still clutter up the pages of the daily newspapers. Many people are still living in the superstition of the middle ages when it was believed that the stars and planetary configurations affected one's destiny. How worthy is a knowledge of the subject if only to rid us of this all-too-prevalent gullibility.

We need not enlarge further upon these more or less practical claims for consideration, for they are unimportant in comparison with the contributions which the pure knowledge side of astronomy has made. Professor Shapley has just referred to the difficulties the astronomer finds himself in by reason of the thin atmospheric covering that surrounds us. That is bad enough but can we picture our present state of civilization if the earth were externally shrouded in clouds, thick enough to obscure the heavenly bodies from view, though not sufficient to cut off the sun's energy. We would, of course, know something of the earth's surface and a mile or so of the atmosphere but we would be creatures of restricted outlook, nevertheless. We would go on with our work of raising potatoes and wheat for food, always looking down, never up, knowing nothing of the great universe, save this thin stratum of earth and air—such would be our condition to-day. Indeed, with the heavens in open view such might even be given as a picture of life 400 years ago before the days of the telescope, the spectroscope and the photographic plate.

The main purpose of astronomy, then, is to understand the universe. It is not that such knowledge will yield any financial returns, although there is rarely ever a discovery in pure science but contributes directly or indirectly to others which have practical applications. However the astronomer works with no such aim in view, but simply for the sake of finding things out.

I have thought that to illustrate something of the advances made in solving

the riddle of the universe during the 29 year interval since I last stood upon this platform on a similar occasion, I might refer to the item of radial velocities mentioned in the all-too-generous citation just read. In 1906 the number of stars whose radial velocities were known was about 400, chiefly determined at the Lick and Yerkes Observatories. The work taken up at Ottawa and for the past seventeen years at Victoria has resulted in Canada having a very creditable share in this phase of astronomical work. Of the 7000 stellar velocities now known, approximately 2000 have been determined at Victoria, although not all have as yet been published. In this work I have had some small share.

Much as has been learned from such researches we can nevertheless say with a great scientist of a former age that what we have explored is but the smallest portion of the great ocean of truth.

President Cody then spoke of the various distinguished guests on the platform and welcomed them individually. He asked Mr. Mackenzie King to address convocation.

Mr. King stated that it was his purpose to attend the opening ceremonies at the observatory without being seen in Toronto or missed in Ottawa. He had been seen in Toronto; how well he had avoided being missed in Ottawa he could learn when he returned. He wished to pay tribute to all those who had contributed to the realization of the construction and completion of the observatory. It was a great day for the University and a great day for the country, but also a day of remembrance for the whole scientific world.

He most warmly thanked Mrs. Dunlap and praised her selection of such a memorial to her husband. The David Dunlap Observatory was a combined monument, resembling a double star, of which the components are so close as to seem to be one, to the generosity of the donor, and to the memory of her husband. He spoke kindly of the long-enduring and unflagging enthusiasm and determination of Dr. Chant, and rejoiced in this happy culmination of his plans.

From his own personal point of view, he spoke of his happiness at being able frequently to return to his Alma Mater. He did not come for relaxation, nor recreation, but because, in the University, he found real inspiration for his own life. And in the realization of such a magnificent, unselfish, and noble project he found an especial inspiration.

Convocation was then dismissed.

SOME ADDITIONAL GREETINGS

From the Dominion Astrophysical Observatory, Victoria, B.C.
(Telegram to C. A. Chant)

Birthday greetings and hearty congratulations to all your staff.
(*Signed*) STAFF, *Dom. Astro. Obsy.*

From the Victoria Centre, Royal Astronomical Society of Canada—to Professor Chant

The Victoria Centre of the Royal Astronomical Society of Canada has learned with much pleasure of the completion of the David Dunlap Observatory with its reflecting mirror of 74 inches diameter.

The Executive desires to extend, on behalf of the Centre, its heartiest congratulations to you upon the fulfilment of your cherished ambition to secure such an observatory for Canada and in particular for the University of Toronto. Through your association with the *Journal* as Editor the members have come to feel that they know you personally and wish to send you this message of congratulation and best wishes for the success of the observatory.

We should like to place on record also our appreciation of the great contribution Mrs. Dunlap has made to the higher life of the country in the gift of such a splendid observatory. The aid she has thus rendered the cause of pure science will, we trust, be an example to other Canadians to do likewise.

To the University which receives this splendid gift to administer, we would offer our congratulations also, realizing that through the use of this new equipment researches will be possible which will add additional lustre to the University.

Signed on behalf of the Victoria Centre, R.A S.C.

H. BOYD BRYDON, *President.* GORDON SHAW, *Secretary.*

From the Vancouver Centre, R.A.S.C.—To Mr. Harper

I wish to thank you for your kind letter, and request that while in the east you convey from the Royal Astronomical Society, Vancouver Centre, hearty greetings and congratulations to Prof. C. A. Chant, to whom we have for many years been deeply indebteded for his valuable services to Astronomy and particularly for his being instrumental in securing the new David Dunlap Observatory for our country.

(*Signed*) C. A. MCDONALD, *Secretary.*

From the Edmonton Centre, R.A.S.C.—To Mr. Harper

I have been instructed by Dr. Gowan, president, to say that we would be glad to have you convey to Dr. Chant greetings and congratulations from the Edmonton Centre of the R.A.S.C.

(*Signed*) G. A. CLARKE, (*Secretary*)

From Prof. J. W. Campbell, University of Alberta, formerly President of the Edmonton Centre.—To C. A. Chant

Our Centre has been glad to join with other Centres of the Royal Astronomical Society in extending to you our best wishes and congratulations on the opening of the new observatory, but I should like to add a personal word of greeting. I want to express my appreciation of your cordial and kindly interest in all the matters that I have had to bring to your attention, and for the generous assistance you have always given when called upon;—and not only for the academic interest and assistance you have given, but also for the cordial hospitality of your own home which it has been my privilege to enjoy.

I regret that Mrs. Campbell and I are not in the east this week to participate in felicitations to you and Mrs. Chant on the occasion of this very fitting recognition and reward for your achievements in the interest of astronomy, but please accept this intimation of our very best wishes to you both.

(*Signed*) J. W. CAMPBELL

From the Winnipeg Centre, R.A.S.C.—To C. A. Chant

It is with great pleasure that we ask Mr. W. E. Harper, who is attending the 1935 meeting of the Royal Society of Canada, to convey to you the greetings of the Winnipeg branch of the R.A.S.C.

We have followed the planning, building, and equipping of the new Observatory at Toronto with great interest and pride, and, realizing how much of this fulfilment is due to the untiring efforts of you and your associates we, on the occasion of the official opening of the David Dunlap Observatory, send you our felicitations, greetings, and hopes that you may be spared long to direct the Observatory, and that, notwithstanding the noteworthy contributions made by Victoria and Ottawa to the science of astronomy, Toronto may outshine them both.

Good luck and good seeing, always!

(*Signed*) WINNIPEG CENTRE,
per L. T. S. NORRIS ELYE (*President*)

From Prof. A. Vibert Douglas, McGill University, Secretary of the Montreal Centre, R.A.S.C.—To C. A. Chant

It is a matter of great regret to me that I cannot be present on the momentous occasion of the official opening of your observatory. I would have liked to add my humble congratulations to those of the many distinguished well-wishers who will be with you on that occasion.

May health and strength be granted you to enjoy the fruit of your labours and to see the David Dunlap Observatory achieve a reputation for valuable

research. May great happiness be yours on your birthday and through the succeeding years.

(*Signed*) A. VIBERT DOUGLAS.

MR. GEORGE R. LIGHTHALL, president of the Montreal Centre, was present at the opening of the Observatory.

DR. RALPH E. DELURY and MR. CLARENCE B. HUTCHINGS of the Ottawa Centre were also present.

PROFESSOR H. R. KINGSTON, former president of the London Centre, with Mrs. Kingston, attended the opening.

Of the Toronto Centre a large number of members were present, including Professor L. Gilchrist, president of the R.A.S.C. and Mr. A. R. Hassard, K.C., chairman of the Centre.

THE DAVID DUNLAP OBSERVATORY*

By R. K. YOUNG

With Plates X-XVII

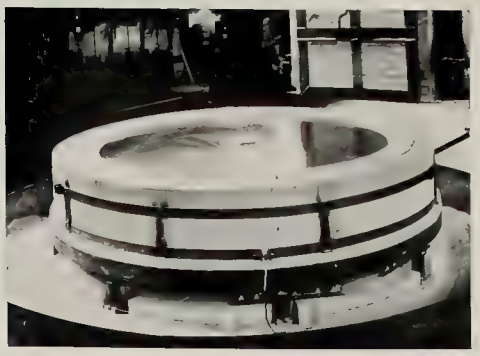
THE David Dunlap Observatory, the gift of Mrs. Jessie Donalda Dunlap to the University of Toronto as a memorial to her husband, will be formally opened on May 31, 1935. It is very fitting that the Observatory should be opened on this date, which is the seventieth birthday of the Director, for Dr. Chant has spent the greater part of his life in fostering astronomy within the University and in encouraging its study throughout Canada. The purpose of this article is to tell briefly the story of this magnificent gift and to say something of the research which will be carried on by the new observatory.

ASTRONOMY IN THE UNIVERSITY

The progress of astronomy as a department of the University is due to the continued efforts of Dr. C. A. Chant to emphasize its importance as a cultural subject in education and as a training for the advanced student. It was a part of his plan, even from a very early date, that the University should have an observatory and contribute to the knowledge of the subject, but it was hardly expected that the money for its erection would be obtained from the provincial grant to the University. In an institution striving to meet the needs of the province and expanding rapidly, chief emphasis in the field of science was likely to be placed on subjects more immediately utilitarian. Not until these had been taken care of would the claims of a pure science like astronomy be considered. The interest in the subject in recent years has been much increased by the spectacular discoveries which have greatly extended our knowledge of the universe and which have appealed to the imagination.

*Reprinted with slight revision from the *University of Toronto Quarterly*, Vol. IV, No. 3, April, 1935.

PLATE XIII



THE DISK OF GLASS FOR THE 74-INCH MIRROR IN ITS MOULD
AT CORNING, N.Y. JUNE 21, 1933

THE DISC IN THE SHOPS AT NEWCASTLE-ON-TYNE, MAY, 1934
The disc has been ground approximately to shape, the boss at the centre is being bored out

PLATE XIV.

THE DISC FOR THE 74-INCH MIRROR
Above: Before grinding began. The rough surface can be seen.
Below: The disc after the rough grinding was finished. When cast the disc was 75 inches in diameter and 14 inches thick. (Photographs of November, 1933.)
From a photograph in the Annual Report of the Corning, 1934.

PLATE XVI

THE GREAT MIRROR.
The mirror has not yet been lifted from its cradle and a belt is about to be placed around it.
May 7, 1934.
In front: T. E. Heard (Asst.) E. S. Hegg.
Behind: A. Young (Supt.) E. O. Shook (Asst.)
From a photograph in the Annual Report of the Corning, 1934.

PLATE XVII

THE GREAT MIRROR
[illegible]
From a photograph in the Annual Report of the Corning, 1934.

Astronomy owes much also to the great body of amateurs whose interest in the subject has strengthened the desire that an efficient telescope might be situated within the province. The late David Alexander Dunlap was one of these. He was a member of the Royal Astronomical Society of Canada and attended the meetings of the Toronto centre. Dr. Chant in all his lectures before the society and throughout the country has emphasized the observational side of astronomy and the need of an observatory. If those who give instruction in astronomy are to possess that inspirational touch which comes only from an intimate knowledge of the subject, they must either be actively engaged in astronomical research, and thus be extending the frontiers of the science, or must be thoroughly informed regarding the work carried on in the observatories of the world. Lacking the equipment for the former, Dr. Chant followed the latter course; but he constantly emphasized the need of a first class observatory. It was his hope that aid in this project would l received from Mr. Dunlap, but the latter's death in 1924 prevent this. When, some time later, Professor Chant suggested to M Dunlap that she should provide the observatory as a memorial to her husband, the suggestion met with a sympathetic response. Indeed, Mrs. Dunlap shared her husband's interest in astronomy.

General Plans and Location

In 1927 Mrs. Dunlap expressed her willingness to provide the observatory, but it was not until June of 1928 that we were in a position to call for the construction of the various instruments which would be installed. The original plan, which has been closely adhered to, contemplated two buildings: one, a steel structure to house a large telescope; the other, an administration building for office work and the reduction of the observations. There was no haste about the construction of the latter building since it offered no particular difficulties, but the main telescope was ordered as soon as possible because the time required for its construction was somewhat uncertain, this being especially true of the large mirror which forms the essential optical part of the telescope.

The location of the observatory was an important point to decide. Dr. Chant and the writer spent many afternoons inspecting the maps of the neighbourhood of Toronto and visiting the possible sites. It was not thought advisable to go more than twenty or twenty-five miles away from the city, and locations north or north-west were much preferable to those east of the city. Most of our clear weather comes with west or north-west winds, and at these times the smoke from the city is blown south-east or east. A considerable amount of experimenting was carried on to determine the transparency of the air thirty, fifteen, and four miles from the city, as well as the amount of sky-illumination. In this regard the stations thirty and fifteen miles away proved far superior to that near the city, especially in the matter of the sky-illumination. The gain between thirty and fifteen miles did not seem to warrant placing the observatory at the more distant station. The site finally chosen is about twelve miles north of the city limits and about five-eighths of a mile to the east of Yonge Street on the highest land in that immediate locality, the summit being eight hundred feet above sea level. The land falls away in all directions, giving a remarkable view of the surrounding country. At present the land around the observatory is quite open, with a few trees and shrubs scattered here and there. From an astronomical point of view it would be better if the land were more heavily wooded. On an open plain the ground becomes hot during the day; and when, after sunset, the heat is given off again, the warm air flowing upwards creates an unsteady atmosphere which interferes with the use of the telescope. Trees and vegetation absorb a great deal of the sun's heat so that a steady state of the air is reached much more quickly. Accordingly, it is intended to make the land into an arboretum to be known as the David Dunlap Park.

Awarding the Contracts

Comparatively few firms possess machinery large enough to handle the massive castings of a great telescope, and there are still fewer with experience in telescope-building. The tentative specifications were sent to four firms: Carl Zeiss in Germany; Sir Howard Grubb, Parsons and Company in England; Warner and Swasey Company of Cleveland; and J. W. Fecker of Pittsburgh. The Warner and Swasey Company did not submit a tender, and the design of the Carl Zeiss firm was considered less satisfactory than the one selected. There was not much difference either in the designs or prices of the other two firms, but after due consideration it was decided to accept the tender of the English company. This was a very fortunate choice because the decrease of the pound sterling made the cost very much less than it would have been if the contract had been let in the United States. It was very satisfactory, also, that the complete contract for the mounting, for the steel building to house the telescope, and also for the optical parts, could be let to one firm. This made it much easier to ensure that the finished equipment would assemble without difficulty when it arrived. Each of these three items merits some description.

The Circular Steel Building

The building to house the large telescope was ordered in November, 1931, and it was received in Toronto on July 31, 1933, (in pieces.) As has been already stated, the entire building is of steel construction. The circular drum and the hemispherical dome resting on it have double walls, and an open space at the base of the building admits air, which circulates to the top and goes out through openings with baffle plates at the upper part of the dome. The inside and outside of the dome are covered with "agasote," a hard paper product, and the outside is further protected by a sheeting of copper. By this means the interior of the building is kept cool during the day, and in the evening when thrown open for observations the whole building soon assumes the temperature of the outside air. Thus the "definition" of the telescope is not interfered with by heated air-currents, as would undoubtedly be the case if any quantity of heat were stored in the walls. The dome, which weighs about eighty tons, rests on twenty-four rollers, twenty-seven inches in diameter, running on a circular track. The entire dome may be rotated so that the opening, which is fifteen feet wide and extends from the bottom to seven feet beyond the zenith, may be made to face any part of the sky. Two parallel shutters run on rails at the top and bottom of the dome and cover or uncover this opening. The building cannot be heated because of the air-currents which would be set up. In the cold weather the observer must dress for the occasion.

The Mounting of the Telescope

The telescope which the building houses is comprised essentially of the big mirror and a suitable means to hold it and direct it toward any part of the sky. The mirror, which consists of a block of glass seventy-six inches in diameter and about twelve inches thick, weighs about five thousand pounds, and consequently the mounting must be correspondingly heavy. This mounting is so constructed that the telescope can be pointed to any desired part of the sky and be continuously moved by clockwork in order to follow any object from the east to the west as it passes across the sky owing to the rotation of the earth. Although the moving parts of the mounting weigh upwards of thirty tons, this motion must be perfectly steady. It demands great perfection in the construction. The completed mounting, with the exception of the mirror, was received in Toronto on October 15, 1933.

The Great Mirror

When the telescope was ordered, in 1930, we knew that the portion which would probably take the longest to complete was the big mirror. At that time the Grubb-Parsons Company controlled the Parsons Optical Glass Works at Derby; and Sir Charles Parsons, the head of the C. A. Parsons and Company, of which these other companies were subsidiaries, was confident that they could manufacture a suitable disk of glass for the telescope mirror. (Incidentally, Sir Charles Parsons was the youngest son of the Earl of Rosse, who completed a six-foot reflector in 1845.) But Sir Charles was in his seventy-sixth year when the order for our telescope was placed, and unfortunately he did not live to see the disk made. Had he lived I have no doubt that his active interest and ingenuity would have solved the difficulties and pushed the task to completion. But in 1932, after his death, the disk had not yet been cast, and it

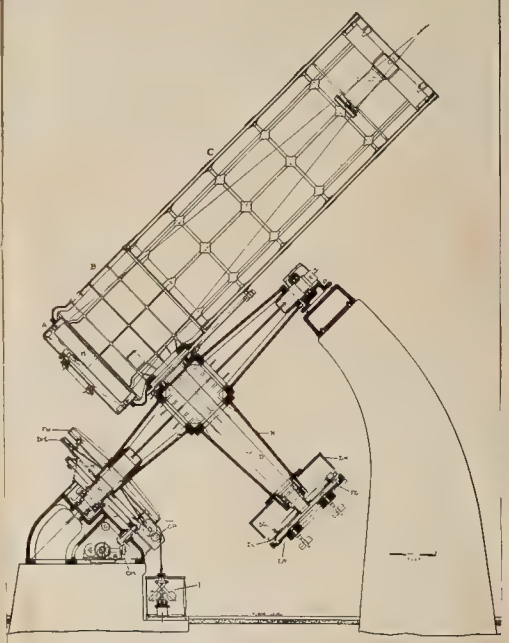


Fig. 1.—Vertical north-south section of the 74-inch telescope

seemed that the project for our observatory might be unduly dealyed.

However, in 1932 unexpected help arrived in connection with the manufacture of telescope mirrors, which was not available in 1930. In the latter year the only firms which would undertake the manufacture of large disks were Carl Zeiss in Germany and the Glass Works at Derby in England. On the American continent the Corning Glass Works, of Corning, N.Y., had made some small "pyrex" disks of glass which were superior in every way to any that had been previously made, but this firm was extensively engaged in the commercial manufacture of pyrex articles and was not prepared to undertake the expensive experimenting necessary to manufacture so large a disk as we required. But between 1930 and 1932 conditions changed. Plans had been put forward for the manufacture of a disk for a two-hundred-inch telescope and time and money spent in finding out the most suitable material. In the end it was decided that "pyrex" glass offered the best hope of success for this disk. The Corning Glass Works was prevailed upon to install the necessary furnaces and annealing ovens for the task. We were informed late in 1932 that they were prepared within six months to cast our disk. From the first we should have chosen this material for the large mirror had it been available at the time. The Grubb-Parsons Company gave the contract for the manufacture of the raw disk of glass, which was to be shipped to England to be ground and polished into the final mirror. It was with great hope and satisfaction that our party from Toronto, including Mrs. Dunlap, Dr. Chant, and others, was present in Corning on June 21, 1933, and saw the disk poured from a special type of "pyrex" developed for telescope mirrors. Possibly with still greater satisfaction Dr. Chant and the writer inspected it on September 29 of the same year after it had come from the annealing oven, and saw a disk whose appearance met all our hopes.

No time was lost in shipping it to England. It was still to be ground and polished, and Mr. C. Young, the manager of the Grubb-Parsons Company, estimated that this would take eighteen months. Only those who have attempted to make a telescope mirror can really appreciate the difficulties that are encountered in such a task. The material is fragile and the disk heavy, and the surface has to be

Fig. 2.—Unloading the Great Mirror from truck into Dome, May 2, 1935

shaped true to an extraordinary degree of accuracy. The figure of the mirror, we are informed, now warrants the makers in ceasing work on it. Measures and photographs which have been received lead us to believe that the surface is in no place at fault more than one millionth of an inch.

The Administration Building

The large telescope will be an effective instrument of research. In addition to the building containing it, it is necessary to have a suitable place where the plates taken with the telescope may be studied, where the staff can have office space, and the activities of the observatory be directed. The construction of the Administration Building was conducted by the University's Superintendent of Buildings and Grounds, who also had charge of the erection of the steel building, of securing the water supply, of the electric installations, and of other essential details. Great credit is due to his management and to the architects, Mathers and Haldenby, for the fine appearance of the building, both within and without. It is a stone structure, built on classical lines, and is situated about two hundred and fifty feet from the great dome.

On the roof of the building three domes were erected for the accommodation of smaller instruments. The central and north domes are at present vacant. In the south dome is a nineteen-inch telescope which was built at the University. This telescope, we hope, will prove a valuable accessory to the larger instrument and may be used on many programmes of research when the large telescope is not available.

In the Administration Building is also the library of the Observatory. Original plans for a special endowment for the library could not be carried out and this essential adjunct to research is not yet satisfactorily provided for. The Observatory and the University of Toronto are indebted to the Royal Astronomical Society of Canada for the loan of the more technical part of its library to the Observatory for a term of three years. The library is not nearly as complete as it should be and will have to be supplemented either by generous grants from the University or from funds obtained from other sources.

The Work of the Observatory

Almost the entire research programme of the Observatory will be carried on photographically. It is estimated that during a year we shall have about one hundred and twenty-five clear nights with twelve hundred observing hours. The large telescope will be in use from sunset to sunrise, either in directly photographing regions of the sky or in the employment of auxiliary instruments such as the spectroscope with which the spectra of the stars are secured. Considerable time will have to be utilized at first in testing the accuracy of the instrument and in determining methods of work in order to make the labour of the limited staff as efficient as possible. Only after operating for a number of years can an observatory have accumulated that wealth of astronomical photographs which forms the basis of research on many astronomical problems. After this is secured there is forthcoming a steady stream of valuable work. It will probably take a number of years for us to reach this goal, and the first duty of the staff will be to accumulate the observational material. While a new observatory is thus handicapped for a time, it has compensating advantages: it can utilize all previous experience in order to obtain the material in a superior form, so that it can be used for more lines of investigation.

On account of the large size of the new telescope, the second largest in the world at the present time, we shall be able to secure much material which has never before been obtained. Astronomers throughout the world, through their organizations and publications, are well informed regarding the work which is being carried on, and the various observatories co-operate in the prosecution of researches for which their equipment is best suited. The David Dunlap Observatory will participate in the field of stellar velocities, spectral photometry, and in other co-operative labours. The major part of the observational programme will be devoted to such researches, and by contributing to the advances in astronomy it is hoped to justify the generosity of the donor in presenting the University of Toronto with this magnificent instrument.

ON RETIRING

During the last twenty years the nature of "time" has been a subject of much lively debate. The publication of Einstein's General Theory of Relativity caused great intellectual quickening, not only in academic circles but among factory workers, in mining camps and in outposts of empire. Is time absolute? Has it a separate independent existence or does it depend on something else?

For two centuries Newton's definition was universally accepted —at least by students of physical science:

> Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration.

Space also is treated by him in similar simple terms which seem clear to all! And yet Einstein and his supporters, who sprang up everywhere, boldly stated that time and space were simply relative notions. According to Minkowski,

> From henceforth space in itself and time in itself sink to mere shadows, and only a kind of union of the two preserves an independent existence.

However when a person is told that he has reached the age of three-score-and-ten and that he must therefore retire, whether he likes it or not, he feels that time is pretty absolute after all.

About two decades ago I had the opportunity of examining the records made at the Meteorological Office at Toronto for many years past. For Wednesday, May 31, 1865, the day of my birth, the following entry was found:

> Temperature at 2 p.m., 76°; mean for the day, 68°.4. Fair day. Hazy round the horizon. Frogs noisy at night.

The site at which these observations were taken is now on the grounds of the University of Toronto. For May 31, 1935, seventy years later, at a station half a mile farther north, the atmospheric conditions are embodied in the following summary which is abstracted from the elaborate record as now taken:

> Temperature at 2 p.m., 69°.9; mean for the day, 64°.01. At 2 p.m. the barometer read 29.759 in. which, reduced to freezing point and sea level, was 30.062 in.; relative humidity, 41; visibility, 8. From 7.45 a.m. to 12 noon, partly cloudy. Light rain from 7.35 a.m. to 9.30 a.m. At 2 p.m., partly cloudy; at 4 p.m. generally clear and sunny.

It need hardly be remarked that to hear the frogs now one would have to travel several miles from this station.

There is another semi-meteorological or semi-astronomical matter which might be referred to. We speak of a blooming maiden of sixteen summers or a hoary veteran of eighty winters, meaning that these individuals are sixteen or eighty years old, respectively; but I have seen only sixty-nine summers although I can claim seventy-one winters. The anomaly is to be credited to the eclipse of 1922, of relativity fame. Leaving our country in June of that year, a summer in Canada was exchanged for a charming winter in Australia, with the numerical result indicated.

It is in no spirit of protest that I withdraw from active service on the staff of the University of Toronto and put on the quiet gown of the emeritus professor. The regulation requiring retirement at a definite age is a good one. There are younger men, keen of mind and vigorous of body, who will carry forward the work. I shall miss the peculiar pleasure experienced by the instructor in his contact with his students, especially when they are growing into manhood and womanhood. But such will not be entirely absent. Life for me began many years ago, assuredly before forty, and it will continue after seventy. In my pleasant quarters at the Observatory I shall have more leisure to pursue investigations in which I am interested.

Further, the projects in the University and the Royal Astronomical Society of Canada, to which I have given special thought and effort, are, I think, now firmly established. They will assist in the moulding of human thought in the future just as astronomical discovery and research have in the past centuries.

During the many years in which I have conducted this JOURNAL I have not printed any verses of which I could claim authorship. Indeed many moons have displayed their phases since I ventured upon the sea of poetry. I hope I may be pardoned if I now introduce some stanzas which were written over forty years ago; and although they do not require any elucidation they may carry a little greater interest if I explain how they came to be produced.

In 1887 after completing my first year examination at the University I went with a class-mate—long since passed away—on my first camping trip. We launched our canoe in the Stony Lake region where there were then very few summer cottages. I find the following brief record:

> On Wednesday, July 13, a very hot day, we went to Jack's River with the intention of climbing the (so-called) Blue Mountain. After walking several hours and losing our way we at last reached the summit. From it was a glorious view. Over a dozen small blue lakes could be seen.

In the autumn of 1891, I was asked to send a contribution to *What-Not*, a magazine published by the Literary Society of the St. Catharines Collegiate Institute. It appeared in the Christmas number. Perhaps it is more appropriate now.

"OLIM MEMINISSE JUVABIT"

I

We camped upon the lakelet's shore,
And paddled on the river's breast;
We slept upon the grassy floor
When earth was in her sable dressed.

We climbed the mountain's rocky side
Beneath a scorching August sun,
And many times our strength was tried
Before the lofty crest was won.

And though at night, so sore of foot,
With toil and heat quite overworn,
Refreshed with sleep, we urged our route
When Phœbus rose the morrow morn.

But now a kindly memory knows
No thought of pain or blistering ray:—
The thorns of pleasure's fragrant rose
All vanish in the after-day.

On Retiring

II

For years, upon the broadening stream
Of learning has our little bark
Been moving on,—too slow, we deem,
But ever on towards the mark.

We search the much-indented shore
And chart the reefs and shoals we see,
Though oft, beneath the heavy oar,
The body sinks in agony.

Upon the bank, with nightly toil,
We seek to climb the rugged steep,
But ere we trudge a single mile
We fain would lie to rest in sleep.

Yet time a rosy glamour throws
O'er all the hardships by the way:—
The thorns of learning's fragrant rose
All vanish in the after-day.

C. A. Chant

According to tentative plans the observatory will be officially dedicated May 31, Dr. Chant's seventieth birthday. Already the huge dome housing the telescope has been erected and the grey sandstone administration building completed. All that is awaited is the all-important mirror, or "eye" of the telescope, now undergoing its final grinding and polishing process at the Parsons Optical Works, Newcastle-on-Tyne, England. This firm is a subsidiary of the Sir Howard Grubb Company which undertook the contract to build the observatory.

Manufacture of the mirror was the greatest accomplishment of the whole undertaking, in Dr. Chant's opinion. The experiment in casting the disc has been a long and tedious process, and for a time the experts assigned to this technical work were compelled temporarily to acknowledge defeat. The commission ultimately was transferred to a firm in Corning, N.Y., where success attended the pouring of a mammoth 200-inch mirror for a California observatory.

The Dunlap mirror was poured into its mould on June 21, 1933, and on October 1, the same year, was declared a complete success. Then it was shipped to England to undergo further technical treatment. Even if the mirror is delivered in Toronto on schedule, nearly two years will have elapsed since work on the telescopic "eye" was started.

"We shall certainly be happy when the mirror is installed, but we have never been impatient," Dr. Chant said. "I would suggest those afflicted with impatience might try astronomy as a cure." In that field results were far from spontaneous, he said, with a premium rather paid to concentration, determination and patience.

Journal of the Royal Astronomical Society of Canada, 1935.

VIEW OF THE DAVID DUNLAP OBSERVATORY FROM THE AIR.

Designed and produced by ROUS & MANN Limited Toronto.